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ANNUAL MEETING

OF

THE POTATO ASSOCIATION OF AMERICA

KANSAS CITY, MISSOURI

DECEMBER 7, 8, 9, 1949

HEADQUARTERS:

HOTEL PHILLIPS

Joint Meeting

with

International Crop Improvement Association

Thursday, December 8 in the Hotel President

Titles of papers for presentation at the meeting should reach Dr. Ora Smith, Cornell University, Ithaca, New York, by November 10, 1949. Abstracts of papers will be due November 15, 1949.

Room rates are as follows: $3.00 to $5.00 single; $5.00 to $8.00 double; $7.00 to $8.00 twins; $12.00 to $18.00 suites. The Hotel Phillips is located at 12th and Baltimore, 1½ blocks from the Hotel President. Make reservations early.

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WEEDING IRISH COBBLER POTATOES WITH 2,4-D

L. L. Danielson[1]

Virginia Truck Experiment Station
Norfolk, Va.

Maximum yields of Irish potatoes and the efficient operation of mechanical diggers are dependent on good weed control. This necessitates the expenditure of considerable money at the present time. The trials described herein were conducted in an effort to find a means of reducing this cost through the use of the chemical weedkiller, 2,4-D.

Methods and Results

1947 *Trials*—Preliminary trials were conducted in 1947. The monohydrate sodium salt of 2,4-D was applied as a spray on growing spring-crop Irish Cobbler potato plants when they were in full blossom. Rates varying from 0.7, 1.4, 2.1, and 2.8 pounds of the 2,4-D acid equivalent per acre were used. The various amounts of the chemical were applied in the equivalent of 100 gallons of water per acre.

No visible injury resulted from the 0.7 pound rate and only very slight injury was observed in the plots treated with the 1.4 pound rate.

[1]Plant Physiologist.

Mild to severe injury resulted from the 2.1 and 2.8 pound rates. Since these preliminary trials were for observational purposes only, yield results were not obtained.

The results of these applications at blossom time indicated that Irish Cobblers were resistant to injury by 2,4-D, though the 1.4 pound rate appeared to be on or near the threshold of injury. Since this rate of application had been found to give satisfactory weed control in other soil treatment and general spray tests in sweet corn, further trials were planned for the following season.

1948 *Trials*—Plantings of Irish Cobbler potatoes were made on the 17th of March using a band application of 2000 pounds of 5-10-5 fertilizer. The land chosen for these plantings had shown a large population of weeds in the previous season. Each plot consisted of 100 plants using five replications in a randomized block design. All plots were barred off on the 30th of March.

The following treatments were applied on the dates indicated:

A.—The monohydrate sodium sale of 2,4-D was applied as a spray on the soil over the row at the rate of 1.4 pounds of the 2,4-D acid equivalent per acre in the equivalent of 100 gallons of water per acre on the 30th of March after the rows were barred off. All cultivation was omitted following treatment.

B.—The butyl ester of 2,4-D was applied as a spray on the soil over the row at the rate of 0.7 pounds of the 2.4-D acid equivalent per acre in the equivalent of 5 gallons of water per acre on the 30th of March after the rows were barred off. All cultivation was omitted following treatment.

C.—This series was treated with the same material at the same rate as in (A) on the 26th of April when the potato plants were six inches high. Spray was applied over the plants in the row as well as on the soil between the rows. Cultivation was omitted on this series following barring off on the 30th of March.

D.—This series was treated with the same material at the same rate as in (B) on the 26th of April when the potato plants were six inches high. Spray was applied over the plants in the row as well as on the soil between the rows. Cultivation was also omitted on this series following barring off on the 30th of March.

E.—These plots represented a control series which received no chemical treatment. Normal cultivation and weeding methods were used.

F.—This series received no chemical treatment and was not cultivated after the rows were barred off on the 30th of March.

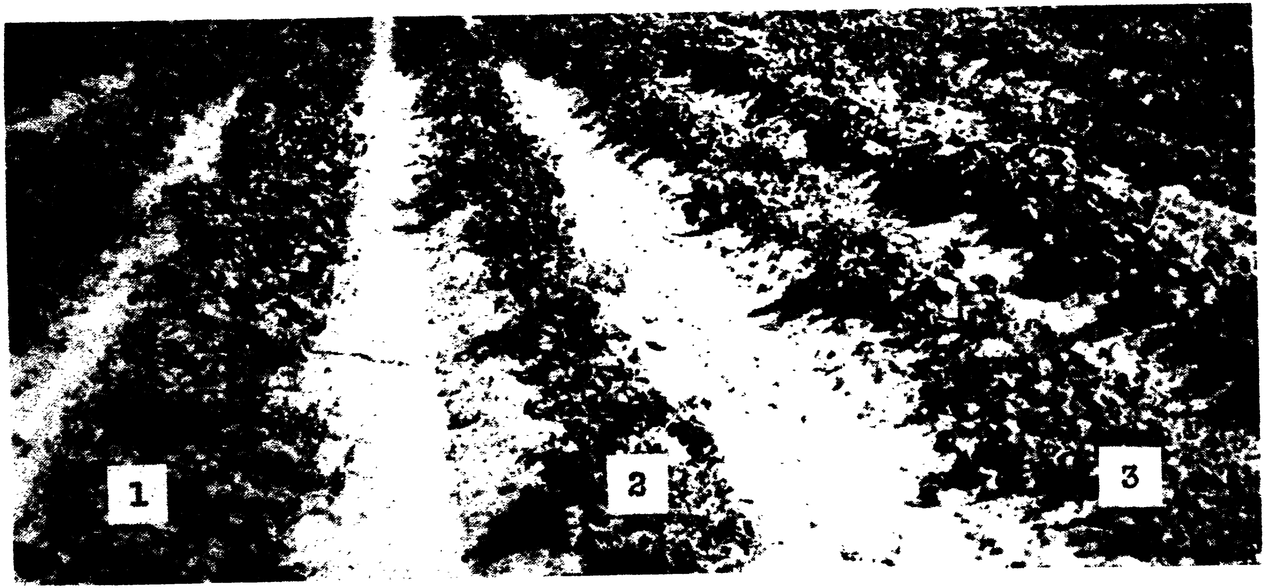

FIG. 1.—Irish Cobbler vines one month after treatment with 2, 4-D when they were 6 inches high. Row (1) received no treatment. Row (2) sprayed in high gallonage treatment with 1.4 pounds of the 2, 4-D acid equivalent per acre in the form of the sodium salt of 2, 4-D. Row (3) sprayed in low gallonage treatment with 0.7 pound of the 2, 4-D acid equivalent per acre in the form of the butyl ester of 2, 4-D.

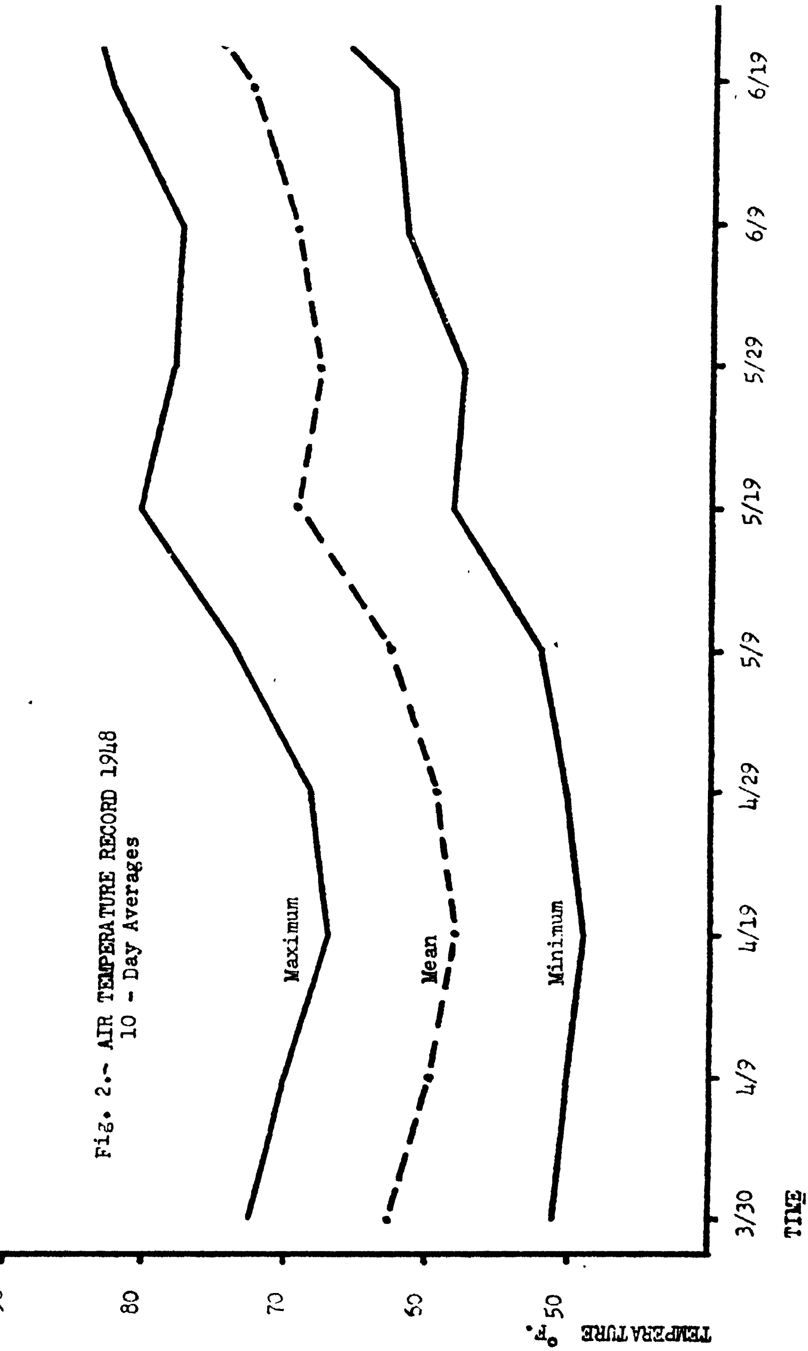
Fig. 2.- AIR TEMPERATURE RECORD 1948
10 - Day Averages
Maximum
Mean
Minimum
TEMPERATURE °F.
90
80
70
60
50
TIME
3/30
4/9
4/19
4/29
5/9
5/19
5/29
6/9
6/19

FIG. 2. Chart.

The high gallonage 2,4-D salt applications were applied at a pressure of approximately 100 pounds. The low gallonage 2,4-D ester applications were applied with TEE-JET 650067 nozzles at a pressure of 30 pounds. The rainfall record during this experiment is given in table 2. The temperature record is given in figure 2. All plots were harvested on the 21st of June. Treatments A and B applied before emergence produced no injury symptoms on the potato vines and did not reduce the yield significantly as shown in table 1. Good control of chickweed (*Stellaria media*) and henbit (*Lamium amplexicaule*) was maintained throughout the spring. Summer weeds such as pigweed (*Amaranthus retroflexus*), lamb's quarters (*Chenopodium album*), and crab grass (*Digitaria sanguinalis*) were retarded for approximately three weeks as compared to untreated plots.

TABLE 1.—*Yield Results* 1948

Treatment	Mean Yield Bu/A. No. 1's	Mean Yield Bu/A. Culls	Yield No. 1's as Per Cent of Uncult. Check
A	130.7	27.7	94.8
B	137.8	29.6	100.0
C	67.8	39.5	49.2
D	94.8	34.2	68.7
E	149.8	33.6	108.7
F	137.8	30.0	——
Diff. for Sig. 5 per cent Level	23.1	——	——

TABLE 2.—*Precipitation Record* 1948

March	Rainfall Inches	April	Rainfall Inches	May	Rainfall Inches	June	Rainfall Inches
17	0.02	1	0.50	2	0.04	1	2.18
23	0.20	2	0.08	5	0.64	7	1.01
24	0.60	7	1.03	7	0.65	8	0.24
27	0.13	8	0.30	13	0.78	14	0.87
		13	0.80	14	0.10	15	1.87
		14	0.89	17	0.64	16	0.07
		15	0.84	26	0.90		
		21	0.97	29	0.90		
		27	0.06	30	1.70		
		28	0.79	31	0.70		
Monthly Totals	0.41		6.26		7.05		6.24

Total during experimental period 19.96 inches.

Treatments C and D applied when the potato plants were 6 inches high produced marked leaf injury symptoms and retarded growth as shown in figure 1, though the plants were not killed. Significant reductions in yield resulted from these treatments as shown in table 1. Satisfactory weed control was maintained for approximately four weeks after which crab grass and other annual grasses began to germinate. Early infestations of the common potato bug (*Leptinotarsa decemlineata*) showed a remarkable preference of these insects for the potato foliage which had been treated with 2,4-D. This observation occurred before differences in height of potato vines in treated and untreated plots were apparent.

The yields from cultivated and uncultivated plots were not significantly different, though the weed populations in the uncultivated plots were high.

DISCUSSION

The results obtained in 1947 on the application of weed killing concentrations of 2,4-D at flowering time on Irish Cobblers indicated considerable resistance to injury. It was felt that applications made at an earlier growth stage when the weeds were in a rapidly growing condition might give better control. The 1948 results showed, however, that treatments applied when the potato vines were six inches high produced severe injury symptoms on the tops and reduced yields significantly. Applications made on the soil immediately after barring off the rows did not produce injury symptoms on the vines and did not reduce yields, but these treatments were made too early in the season to give effective control of summer weeds. These trials suggest the possibility of using pre-emergence applications on the fall crop since very satisfactory control of summer growing weeds has been obtained with soil treatments with these rates of 2,4-D made on other crops after the 1st of June.

The results presented here suggest the need of further study of the effect of different rates of application of 2,4-D at various growth stages. This is also indicated by the work of Ennis *et al* (1) in which it was shown that Irish Cobbler potatoes were quite resistant to applications of approximately 1.0 pound of 2,4-D per acre at various growth stages prior to flowering.

Varietal differences in resistance to injury by 2,4-D have been reported by Thompson and Shuel (3) who found the Katahdin variety more resistant than the Irish Cobbler to weed-killing concentrations of 2,4-D applied at flowering time. It is interesting that Bradley and Ellis (2) also report the satisfactory control of weeds with 2,4-D in the

Katahdin variety without a reduction in yield. The results obtained by these workers and the results reported in the present paper emphasize the need for further study of varietal resistance before any general recommendations are made for the use of 2,4-D for the control of weeds in Irish potatoes.

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FURTHER STUDIES ON THE INFLUENCE OF SPROUT-INHIBITING AND SPROUT-INDUCING TREATMENTS ON THE GROWTH AND YIELDS OF POTATOES.[1]

Humberto Gandarillas[2] and R. E. Nylund[3]

Minnesota Agricultural Experiment Station, St. Paul 1, Minn.

In a previous study (1) it was found that seed potatoes which had been treated with methyl ester of naphthaleneaceptic acid (MNA) on the 17th of January and then treated, two days before planting, with ethylene chlorhydrin (EC) produced stands as good as those from untreated tubers. Plants from treated tubers emerged more slowly than did plants from untreated tubers. This delay in emergence was thought to be associated with the lower yields obtained from the treated tubers. It was thought that a longer time interval between ethylene chlorhydrin treatment and planting date might result in the more rapid emergence of sprouts from the napthaleneacetic acid-treated tubers.

The objects of the experiment reported here were (1) to determine the relation of time of treatment with MNA to its effectiveness in inhibiting sprouting of stored potato tubers, and (2) to determine the relation of time of EC-treatment of MNA-treated seed potatoes to growth and yields of potatoes.

[1]Paper No. 2394 of the Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul, Minn.

[2]Formerly graduate student in Horticulture, now Assistant Professor, Escuela de Agronomia, Universidad de San Simon, Cochabamba. Bolivia.

[3]Assistant Professor of Horticulture.

MATERIALS AND METHODS

In the fall of 1946, in order to determine the most effective time of treatment to inhibit sprouting and of treatment to induce sprouting of potatoes stored at two temperatures, a factorial experiment was set up involving the following treatments:

1. Four dates of treatment with methyl ester of naphthaleneacetic acid: October 8, November 8, December 7, and January 8.
2. Three dates of treatment with ethylene chlorhydrin to induce sprouting: March 10, April 8, and May 2.
3. Storage at 36-40° F. and at 50-53° F.

All possible combinations of the above treatments including untreated control lots for each date were made, resulting in a total of 40 treatments. Each treatment was applied to one lot of Irish Cobbler tubers weighing four kilograms. All tubers were placed in storage on October the 8th.

The chemical treatments applied to inhibit and to induce sprouting have been described in a previous report (1). The sprout-inhibiting chemical, methyl ester of napthaleneacetic acid, (MNA), was applied at the rate of 20 milligrams per kilogram of tubers using talc as a carrier. The chemically-treated talc was sprinkled on the tubers stored in double-walled 20-pound kraft paper bags and the bags were then closed and vigorously shaken to assure complete dusting of all tubers. To induce sprouting, the paper bags containing the tubers were opened and placed in individual tin containers . Forty per cent ethylene chlorhydrin, (EC), at the rate of 1.3 milligrams per cubic decimeter of container volume was sprinkled on absorbent cotton on a watch glass placed above the tubers. A friction-top cover was fitted tightly on each container to prevent escape of the vaporizing ethylene chlorhydrin. After 24 hours, the bags containing the tubers were removed from the tin containers and replaced into storage at the proper temperature.

Beginning on the 23rd of December, all lots were examined at fourteen-day intervals and the loss in weight, number of tubers sprouted, and length of sprouts were recorded for each lot. Sprout length was classified as follows:

Class 1: sprouts - 0-1 cms. in length
Class 2: sprouts - 1-3 cms. in length
Class 3: sprouts longer than 3 cms.

On the 8th of May the forty lots of tubers were planted in the field at University Farm. Each lot was divided to provide four one-rod rows of twenty hills each. Plots were completely randomized within each of the

four blocks. Plant emergence was recorded at four-day intervals from time of planting. In midseason, the number of stems per hill, and, at harvest, the yield per plot was recorded.

Effects of Treatments on Storage of Potatoes

Table 1 gives the percentage of tubers sprouted at intervals following treatment with MNA on the 8th of October, the 8th of November, the 7th of December, and the 8th of January. Tubers stored at 36-40°F. began to sprout in early February and by the 3rd of March all lots stored at that temperature had sprouted. The treatment of tubers with MNA delayed the development of sprouts only slightly. The treatment on the 8th of January with MNA appeared to be more effective in delaying sprouting than were earlier treatments. However, none of the differences between dates of treatment were statistically significant. Tubers stored at 50-54°F. began to sprout at least forty days before those stored at 36-40°F. At the higher temperature MNA was more effective in delaying sprouting than at the lower temperature. All untreated tubers had sprouted by the 20th of January whereas the sprouting of treated tubers, regardless of date of treatment, was delayed about 14 days. A statistical analysis of the data showed that on the 23rd of December and the 20th of January all treated lots had fewer sprouted tubers than did the untreated lots. On the 20th of January however, lots treated on the 8th of October had a higher percentage of

Table 1—*Percentage of tubers sprouted on indicated dates after treatment with MNA on October 8, November 8, December 7, or January 8.*

Date of Treatment with MNA:	Per cent Tubers Sprouted on Indicated Date*					
	12/23	1/6	1/20	2/3	2/17	3/3
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
		Storage Temperature: 36-40°F.				
Untreated	0	0	0	3	24	100
Oct. 8	0	0	0	5	22	100
Nov. 8	0	0	0	2	17	100
Dec. 7	0	0	0	2	11	100
Jan. 8	—	—	0	2	10	100
	Storage Temperature: 50-54°F.					
Untreated	62	80	100			
Oct. 8	30	60	88	100		
Nov. 8	14	36	65	99	100	
Dec. 7	28	54	74	99	100	
Jan. 8	—	—	82	98	100	

*Means given are based on four 4-kg. samples.

sprouted tubers than did lots treated on the 8th of November and the 7th of December. It is apparant from the data presented in table 1 that MNA was more effective in delaying sprouting when applied as late as possible in the storage period but before tubers had begun to sprout. Further support for the above statement is provided in table 2 which shows the length of sprouts of untreated and MNA-treated tubers stored at 50-54° F. Treatment of tubers on the 7th of December a few days before tubers began to sprout, inhibited sprout growth much more effectively than did the earlier and later treatments.

TABLE 2—*Length of sprouts of untreated and MNA-treated Cobbler potatoes stored at 50-54° F.*

Date of Treatment with MNA:	Length of Sprouts on Indicated Dates*					
	12/46	2/3	3/3	3/31	4/14	4/28
	Class	Class	Class	Class	Class	Class
Untreated	1	1	2	2	2	3
Oct. 8	1	1	1	2	2	3
Nov. 8	1	1	1	1	1	2
Dec. 7	1	1	1	1	1	1
Jan. 8	-	1	1	1	1	2

*Class values: class 1—sprouts 0-1 cm. in length.
class 2—sprouts 1-3 cm. in length.
class 3—sprouts longer than 3 cm.

The losses in weight of tubers stored from the 8th of October to the 28th of April at 36-40° F. and at 50-54° F. were 5.7 per cent and 8.3 per

TABLE 3—*Emergence of plants in the field from MNA-treated tubers.*

Date of Treatment with MNA:	Number of Plants Emerged by the Indicated Dates*					
	May 28	June 4	June 10	June 17	June 23	July 3
	Number	Number	Number	Number	Number	Number
	Storage Temperature: 36-40° F.					
Untreated	0.2	0.9	19.2	19.7		
Oct. 8	——	0.4	9.5	14.7	16.6	17.9
Nov. 8	——	0.2	8.1	14.2	17.4	17.7
Dec. 7	——	0.6	9.5	15.2	17.9	18.3
Jan. 8	——	0.3	11.1	16.7	18.7	19.0
	Storage Temperature: 50-54° F.					
Untreated	0.9	12.8	19.6	19.7		
Oct. 8	——	2.4	13.6	16.8	18.6	
Nov. 8	——	2.9	16.6	18.6	19.4	
Dec. 7	——	1.1	14.6	18.2	19.3	
Jan. 8	——	1.4	12.6	16.2	17.6	

*Data given are means of 16 plots. Tubers planted May 8.

cent of the initial weight, respectively. Neither MNA treatments nor EC treatments significantly affected the losses in weight of tubers stored at the two temperatures.

Effects of Treatments on Growth and Yields

The effects of treatment of seed potatoes with MNA on the rate of plant emergence in the field are shown in table 3. Sprouts from untreated tubers started to emerge on the 28th of May, twenty days after planting. All plants from untreated, low temperature-stored tubers had emerged in 40 days whereas those from untreated, high temperature-stored tubers had emerged in 33 days. Treatment with MNA, regardless of the date of treatment, delayed emergence by 16 days and by 11 days from tubers which had been stored at low and at high temperatures, respectively. In table 4 are shown the effects of EC treatment on plant emergence. EC-

TABLE 4—*Emergence of plants in the field from EC-treated tubers.*

Date of Treatment with EC:	Number of Plants Emerged by the Indicated Dates*					
	May 28	June 4	June 10	June 17	June 23	July 3
	Number	Number	Number	Number	Number	Number
	Storage Temperature: 36-40°F.					
Untreated	0.1	2.5	9.6	14.8	17.8	18.4
March 10	0.1	2.0	10.4	15.9	17.9	18.4
April 8	——	2.0	9.6	14.2	16.9	17.7
May 2	0.1	3.4	16.3	19.0		
	Storage Temperature: 50-54°F.					
Untreated	0.4	3.0	12.5	16.7	18.4	
March 10	0.2	4.9	16.3	17.9	18.9	
April 8	0.2	4.8	16.3	18.2	18.9	
May 2	0.1	3.5	16.3	18.6		

*Data given are means of 20 plots. Tubers planted May 8.

treatment was effective in hastening emergence of plants from low temperature-stored, MNA-treated tubers only when applied on the 2d of May, six days before planting. MNA-treated tubers which had been stored at the higher temperature responded to EC treatment regardless of when the EC treatment was applied. Emergence of plants from untreated tubers was complete in 40 days whereas emergence from MNA-treated tubers which had received EC treatment on the 2nd of May was complete in approximately 43 days. However, it is apparent from the data in table 3 that for the first 30 to 35 days after planting, plants from MNA-treated tubers which had been subsequently treated with EC were slower to emerge than were plants from untreated tubers.

The effects of treatment of tubers with MNA and with EC on plant stands are shown in table 5. The treatment of tubers with MNA tended

TABLE 5—*Final stand of plants (in per cent) from MNA- and EC-treated tubers which had been stored at 36-40°F. and at 50-54°F.*

Date of Treatment with MNA:	Date of Treatment with EC:	Per cent Stand from Tubers Stored at Indicated Temperature: 36-40°F. Per cent	50-54° Per cent	Mean Per cent
Untreated	Untreated	100	100	100
	March 10	97.5	98.5	98.0
	April 8	100	97.5	98.5
	May 2	97.5	97.5	97.5
Oct. 8	Untreated	82.5	93.5	88.0
	March 10	96.5	88.5	90.5
	April 8	82.5	97.5	90.0
	May 2	100	97.5	98.5
Nov. 8	Untreated	87.5	98.5	93.0
	March 10	91.0	97.5	94.0
	April 8	80.0	97.5	88.5
	May 2	96.0	97.5	96.5
Dec. 7	Untreated	95.0	91.0	93.0
	March 10	90.0	100	95.0
	April 8	85.0	97.5	91.0
	May 2	97.5	97.5	97.5
Jan. 8	Untreated	95.0	83.5	89.0
	March 10	90.0	90.0	90.0
	April 8	96.0	85.0	90.0
	May 2	98.5	95.0	96.5
		7.0*	7.0*	5.3*

*Difference necessary for significance at 5 per cent level.

to result in reduced stands. However, treatment of MNA-treated tubers with EC tended to increase stands, and when such EC treatment was applied six days before planting, the stands obtained were as good as stands obtained from untreated tubers.

The mean number of stems per seed piece for the various combinations of MNA and EC treatments are given in table 6, Treatment of tubers with MNA resulted in the emergence of fewer stems per seed piece. The treatment of both untreated and MNA-treated tubers with EC tended to increase the number of stems per seed piece. However, MNA-treated tubers did not produce as many stems as untreated tubers even when subjected to EC treatment. EC treatment was most effective

in increasing the number of stems when applied on the 2d of May to tubers stored at 36-40° F., but the March 10 treatment was, with one exception, most effective on tubers stored at 50-40° F.

TABLE 6—*Number of stems per seed piece from MNA- and EC-treated tubers which had been stored at 36-40° F. and at 50-54° F.*

Date of Treatment with MNA:	Date of Treatment with EC:	Number of Stems per Seed Piece from Tubers Stored at Indicated Temperature:		
		36-40° F. Number	50-54° Number	Mean Number
Untreated	Untreated	3.7	2.9	3.3
	March 10	3.5	3.9	3.7
	April 8	3.5	3.2	3.4
	May 2	3.9	3.5	3.7
Oct 8	Untreated	1.4	2.0	1.7
	March 10	2.1	2.5	2.3
	April 8	1.5	2.4	1.9
	May 2	2.6	2.3	2.4
Nov. 8	Untreated	2.0	2.1	2.0
	March 10	1.8	2.0	2.3
	April 8	1.8	2.3	2.1
	May 2	2.3	2.5	2.4
Dec. 7	Untreated	1.6	1.8	1.7
	March 10	1.9	2.9	2.4
	April 8	1.5	2.6	2.2
	May 2	2.2	2.5	2.4
Jan. 8	Untreated	1.6	1.7	1.6
	March 10	2.2	1.9	2.1
	April 8	2.3	1.9	2.1
	May 2	2.4	2.5	2.4
		0.4*	0.4*	0.3*

*Difference necessary for significance at 5 per cent level.

The effects of MNA and EC treatments on yields are shown in table 7. Treating of stored tubers with MNA resulted in approximately 22 per cent reduced yields when such tubers were used as seed. Variations in time of MNA application had no significant effects on yields obtained. Treatment of previously untreated tubers with EC did not result in increased yields. EC treatment of MNA-treated tubers resulted in small, but statistically significant increases in yields, particularly when the EC was applied six days before planting. However, it must be pointed out that the EC treatment was effective in increasing yields only when applied to tubers which had been least affected by the MNA treatments (made on

TABLE 7—*Yield of potatoes from MNA-treated and EC-treated tubers.*

Date of Treatment with MNA:	Date of Treatment with EC:	Mean Yield per Plot from Tubers Stored at Indicated Temperatures:		
		36-40° F. Pounds	50-54° F. Pounds	Mean Pounds
Untreated	Untreated	44	42	43
	March 10	42	40	41
	April 8	40	40	40
	May 2	43	42	43
Oct. 8	Untreated	27	31	29
	March 10	33	32	33
	April 8	27	36	32
	May 2	37	31	34
Nov. 8	Untreated	30	34	32
	March 10	31	32	31
	April 8	29	37	33
	May 2	32	35	34
Dec. 7	Untreated	34	33	33
	March 10	34	36	35
	April 8	26	35	30
	May 2	35	34	34
Jan. 8	Untreated	32	30	31
	March 10	34	30	32
	April 8	34	30	32
	May 2	37	34	36
		5*	5*	4*

*Difference necessary for significance at 5 per cent level.

the 8th of October and the 8th of January with tubers stored at 36-40°F.).

DISCUSSION

In this study, the application of methly ester of naphthalenaecetic acid at the rate of 20 milligrams per kilogram of tubers did not reduce shrinkage losses in tubers stored at 36-46°F. and at 50-54°F. Such treatment did, however, significantly retard sprout growth of stored tubers. Thus, had the sprouts which developed been removed before weighing, it is apparent that the loss in weight of untreated tubers would have exceeded that of MNA-treated tubers. Limited studies on the rate of respiration of MNA-treated and untreated tubers indicated that, although the weight losses in both lots were similar, the rate of CO_2 evolution from MNA-treated tubers was, twelve days after treatment, considerably lower than from the untreated tubers.

Results of treatment with EC to induce sprouting of MNA-treated tubers indicate that treatment shortly before planting (6 days) was more effective in hastening sprout growth, as reflected in plant emergence, stem number, stands and yields, than were earlier treatments. However, the present work substantiates results obtained previously (1) which showed that MNA-treated tubers even when treated with EC to hasten sprouting were slower to emerge than untreated tubers and produced lower yields. Calculation of the correlation coefficient between the number of plants emerged by the 10th of June (37 days after planting) and the yield gave a highly significant correlation coefficient of +.804 indicating fairly close association between yields and speed of plant emergence. A comparison of the data in tables 6 and 7 also indicates association between stem number and yields. The correlation coefficient between number of stems per hill and yield per plant was found to be +.799, a highly significant correlation. MNA-treatment of tuber delayed emergence and also reduced the number of stems per hill. Both of these factors apparently were associated with the low yields resulting from the MNA treatment. Although treatment of MNA-treated tubers with EC hastened germination and tended to increase the number of stems produced, the yields were only slightly affected.

Summary

1. Cobbler seed potatoes were dusted with methyl ester of naphthaleneacetic acid (MNA) at the rate of 20 milligrams per kilogram of tubers on the 8th of October, the 8th of November and on the 7th of December 1946, and on the 8th of January, 1947. Lots of each group were placed into storage at two temperatures: 36-40° F. and 50-54° F. on the 8th of October.

2. On the 10th of March and on the 8th of April and on the 2nd of May tubers which had previously been treated with MNA were treated with ethylene chlorhydrin (EC) to induce sprouting. All lots were planted in the field on the 8th of May.

3. MNA was most effective in delaying sprouting and retarding sprout growth when applied to stored tubers as late as possible in the storage period, but before tubers had come out of their rest period.

4. MNA treatment, although it delayed sprouting and retarded sprout growth, caused no measurable reduction in weight loss when tubers and attached sprouts were weighed together. Limited determinations of respiration rates, however, indicated that the rate of respiration of MNA-treated tubers was considerably lower than that of untreated tubers.

5. MNA-treatment of seed tubers delayed emergence of plants in the field from 11 to 16 days. Treatment of MNA-treated tubers with EC six days before planting reduced this delay in emergence to only three days.

6. MNA treatment of seed tubers reduced the number of stems produced per plant by approximately 50 per cent. Treatment of MNA-treated tubers with EC six days before planting resulted in plants having 28 per cent fewer stems than had untreated plants.

7. MNA-treatment of seed tubers tended to result in reduced stands of plants. The treatment of MNA-treated tubers with EC six days before planting, resulted in stands equal to those obtained from untreated tubers.

8. Yields were found to be associated with both earliness of emergence and stem number. EC treatment did not completely counteract the inhibiting effects of MNA treatment on the rate of sprout growth and sprout number.

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APHID CONTROL ON POTATOES

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INTRODUCTION

Aphid infestations of potatoes have been the object of research in many potato growing areas for a number of years (1) (2) (4). The problem of controlling aphids, because of the possible damage which can be inflicted by the presence of high numbers of individuals with their feeding activities, is of secondary importance to the insidious spread of some of the important potato viruses by these insects. This creates a

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control problem of paramount importance and difficulty, especially from the standpoint of obtaining virus-free seed potatoes.

In Kern County, California, one of the largest potato growing sections in the United States, the spread of virus diseases by aphids, particularly during the cooler portions of the year, is of extreme interest and importance. During the spring of 1948, two series of small replicated plots were established in Kern County to test the efficacy of some of the newer organic chemical compounds which are being used for insecticides. The object of these preliminary trials was aphid control, and no attempt was made to determine the effect of the treatments upon virus disease spread.

Materials and Methods

Two localities were chosen, in which to establish a series of replicated plots. One of these areas was in the Shafter district, on the Calolina Ranch, and the other was a field located in the Arvin district of Kern County. The two localities presented differences in type of aphid populations, and differences in dates of planting and harvesting.

Table 1.—*Results* of various treatments on the control of aphids on potatoes in Kern County, California, spring* 1948.

Treatment	Mean Number of Aphids per 10 Leaf Samples
DDT 5 per cent; sulfur 50 per cent; inert carrier 45 per cent	11.4
Nicotine 3.6 per cent; guaranteed alkaloid, inert carrier 96.4 per cent	30.0
BHC 1 per cent; gamma isomer; other isomers 6.6 per cent; inert carrier 92.4 per cent	7.85
Parathion 0.5 per cent; inert carrier 99.5 per cent	3.9
Check, untreated	73.9
Difference required for significance	
5 per cent level	7.90
1 per cent level	10.43

*The results are based upon 5 different pre-treatment aphid counts. These counts were made 24 hours prior to each of the three insecticide applications, and include the two additional pre-treatment counts which were made at the normal weekly interval for two weeks following discontinuation of the treatments.

The individual plots were composed of six rows, 50 feet in length of field-planted potatoes. Four randomized replications of four treatments and a check plot were used.

For purposes of sampling, only the center four rows of each plot were sampled, the two outside rows serving as buffer rows. The insecticides were applied as dusts, and with the exception of one experimental dust (parathion), were commercial formulations of standard available insecticides. The composition of the various dusts was as follows:

(1) DDT (dichloro—diphenyl—trichloroethane), 5 per cent; sulfur, 50 per cent, inert carrier, 45 per cent.

(2) Nicotine, guaranteed nicotine alkaloid, 3.6 per cent; inert carrier, 96.4 per cent.

(3) BHC, gamma isomer of benzene hexachloride, 1.0 per cent; other isomers, 6.6 per cent; inert carrier, 92.4 per cent.

(4) Parathion (O, o—diethyl O, p—nitrophenyl thiophosphate), 0.5 per cent; inert carrier, 99.5 per cent.

The insecticides were applied with a rotary type of hand duster, and the rate of application varied from 33 to 44 pounds per acre.

Pre-treatment and post-treatment samples were taken from the four count rows in all of the plots. The samples consisted of five leaves taken from the upper portion of five plants selected at random throughout the count rows, and five bottom leaves taken in the same manner. The bottom leaves were in contact with the ground. The leaves in almost all instances, were removed from the plants. An examination of both surfaces was visual, and the aphids were counted and recorded under three categories, each with subdivisions as to form. The species categories used were: (1) *Myzus persicae* (Sulzer), the green peach aphid; (2) *Macrosiphum* sp., which included the potato aphid, *M. solanifolii* (Ashmead); and (3) incidental or occasional species. Under each heading the individuals were recorded as being either: (1) alatae (winged females), (2) nymphs, and (3) apterae (wingless females).

The pre-treatment counts were made 24 hours prior to treatment, and the post-treatment counts were made 24 hours following application. The dusts were applied early in the morning at weekly intervals. A total of three applications was made, after which treatment was discontinued, since the next pre-treatment count (a week following the third application) indicated that the population was declining, and that the effect of the previous treatment was still apparent. A fifth sample was made two weeks following the last dusting, and this confirmed the previous indication that the population was on the decline.

Results

The primary species concerned in both areas was the green peach aphid, with two *Macrosiphum* species: *M. solanifolli* (Ashmead) and *M. pisi* (Kalt.), the pea aphid, being the next most abundant species. The green peach aphid made up approximately 95 per cent of the total number of aphids counted.

The results of the samples were tabulated and subjected to an analysis of variance. For these analyses, only the pre-treatment counts were utilized, since these counts gave a more adequate scale by which to evaluate the season's work in respect to the action of the insecticides over weekly periods, and the general aphid population trends. When the results are considered as a whole (table 1), it can be seen that all of the insecticides used were of value in obtaining reduction in aphid numbers. For purposes of convenience, each material will be discussed separately.

DDT-Sulfur:—(Average rate of application: 41 pounds per acre). From a total seasonal standpoint, with no concern as to locality or par-

TABLE 2.—*Results of aphid control treatments indicating the influence of the treatments at the two locations.*

Treatment	Mean Number of Aphids per 10 Leaf Samples	
	Shafter	Arvin
DDT 5 per cent; sulfur 50 per cent; inert carrier 45 per cent	17.85	4.95
Nicotine 3.6 per cent; guaranteed alkaloid, inert carrier 96.4 per cent	46.85	13.2
BHC 1 per cent; gamma isomer; other isomers 6.6 per cent; inert carrier 92.4 per cent	10.1	5.6
Parathion 0.5 per cent; inert carrier 99.5 per cent	4.05	3.75
Check, untreated	117.1	30.70
Mean locations	39.2	11.6
Diff. req. for signif. between treatments		
5 per cent level	11.18	
1 per cent level	14.76	
Diff. req. for signif. between locations		
5 per cent level	5.01	
1 per cent level	6.62	

ticular week (table 1), this treatment was more effective in aphid control than nicotine, approaching BHC and parathion in effectiveness. However, under conditions of low population, such as found in the Arvin district, all the insecticides used were effective in checking the build up of aphids (tables 2 and 4). At Shafter, where a rapidly increasing and rel-

atively high population occurred, the seasonal effectiveness of DDT-sulfur could be considered as being less than that of parathion, but quite comparable to that obtained through the use of BHC (table 2). However, tables 3 and 4 indicate that the final effectiveness of repetitive DDT-sulfur applications is quite comparable to parathion, and that the apparent lack of effectiveness on a total seasonal basis was caused by the slowness with which the DDT-sulfur dust acted. This slowness gave the treatment approximately a two-week lag under the Shafter conditions, but both tables 3 and 4 illustrate the point that once the DDT-sulfur had begun to act effectively upon the population, considerable reduction in numbers occurred despite the discontinuation of treatment.

The slowness of the action of DDT-sulfur dust upon a relatively rapidly increasing aphid population should be considered when contem-

TABLE 3.—*Results of aphid control treatments indicating the influence of the various treatments upon the weekly populations.*

Treatment	Mean Number of Aphids per 10 Leaf Samples Week				
	(1)* 1st	(2)* 2nd	(3)* 3rd	4th	5th
DDT 5 per cent; sulfur 50 cent; inert carrier 45 per cent	4.5	14.5	26.7	9.1	2.1
Nicotine 3.6 per cent; guaranteed alkaloid, inert carrier 96.4 per cent	5.37	16.87	71.87	35.3	20.6
BHC 1 per cent gamma isomer; other isomers 6.6 per cent; inert carrier 92.4 per cent	8.25	7.50	17.5	3.12	2.87
Parathion 0.5 per cent; inert carrier 99.5 per cent	4.12	3.62	6.87	2.5	2.37
Check, untreated	6.87	22.2	133.0	147.0	60.67
Mean weeks	5.82	12.95	51.20	39.42	17.67
Diff. req. for signif. between treatments					
5 per cent level	17.68				
1 per cent level	23.35				
Diff. req. for signif. between weeks					
1 per cent level	7.90				
5 per cent level	10.43				

*The numbers in the parentheses indicate when the various weekly treatments were applied in respect to the pre-treatment counts.

TABLE 4.—*Results of aphid control treatments indicating the influence of the various treatments upon the weekly aphid populations at the two locations.*

Treatment	Mean Number of Aphids per 10 Leaf Samples Location									
	Shafter Week					Arvin Week				
	(1)* 1st	(2)* 2nd	(3)* 3rd	4th	5th	(1)* 1st	(2)* 2nd	(3)* 3rd	4th	5th
DDT 5 per cent; sulfur 50 per cent; inert carrier 45 per cent	7.5	19.25	48.25	10.25	4.0	1.5	9.75	5.25	8.0	0.25
Nicotine, 3.6 per cent guaranteed alkaloid; inert carrier 96.4 per cent	8.55	21.5	126.5	41.25	36.25	2.25	12.25	17.25	29.5	4.75
BHC 1 per cent gamma isomer; other isomers 6.6 per cent; inert carrier 92.4 per cent	13.25	6.75	23.75	2.0	4.75	3.25	8.25	11.25	4.25	1.0
Parathion 0.5 per cent; inert carrier 99.5 per cent	7.5	0.5	6.0	2.75	3.5	0.75	6.75	7.75	2.5	1.25
Check, untreated	13.0	31.5	220.5	206.75	113.75	0.75	13.0	45.5	87.25	7.0
Mean weeks	9.95	15.90	85.0	52.6	32.5	1.7	10.0	17.4	26.25	2.85
Diff. req. for signif. between treatments										
5 per cent level	24.99									
1 per cent level	33.00									
Diff. req. for signif. between weeks										
1 per cent level	11.18									
5 per cent level	14.76									

*The numbers in the parentheses indicate when the various weekly treatments were applied in respect to the pre-treatment counts.

plating the use of this combination for aphid control on potatoes. The indications were that this dust could be used fairly effectively as a preventive insecticide against the green peach aphid, but that in order to realize its full value, it should be present in lethal quantities prior to population build-up.

Species tabulations indicated a tendency for the DDT-sulfur dust to be less effective against the *Macrosiphum* species of aphids present than against the green peach aphid. The numbers involved were too small to be conclusive, but the effectiveness of the insecticide against species groups should be an additional consideration in planning control. This differential of action against the *Macrosiphum* species has been noted before (1).

Nicotine: (Average rate of application: 40 pounds per acre). The form of nicotine used (guaranteed 3.6 per cent nicotine alkaloid) was only slightly effective in aphid control under these conditions (table 1). When used against a relatively high and rapidly increasing population (Shafter), it did not give the control that was obtained with DDT-sulfur, BHC, or parathion (table 2). Under the conditions of low and relatively sedentary population (Arvin), its effectiveness was a little more apparent (table 3 and 4).

Low morning temperatures, and the presence of slight breezes mitigated against the effectiveness of the nicotine. Post treatment counts indicated that the nicotine was acting rapidly, and the immediate drop in population level was noticeable. However, no residual action was expected or apparent, and the recovery of the population was rapid as brought out by the relatively high mean values found for nicotine in all of the tables.

BHC: (Average rate of application: 33 pounds per acre). This material has been reported to impart a disagreeable odor and taste to the potato tuber (3). In view of this, it cannot be recommended for use upon commercial potato planting for insect control.

From an entomological point of view, the material used was a good aphicide (tables 1, 2, 3, and 4). The initial kill was rapid and heavy, and the additional advantage of residual action was fairly pronounced.

Parathion: (Average rate of application: 44 pounds per acre). This was the most recently introduced of the organic materials used, and also one of the best materials tried. It is a thiophosphate, and highly toxic to man and animals as well as to aphids. Under the conditions which obtained at Shafter, the material had a seasonal advantage over the DDT-sulfur dust (table 2), but this was due to the slowness of action exhibited by the DDT-sulfur dust.

The post-treatment counts indicated that parathion was acting rapidly in killing the aphids present, and it had a residual action of considerable consequence (tables 3 and 4). When it was used under the low population conditions at Arvin, its advantage over the DDT-sulfur was not indicated. However, it appeared to be the most promising insecticide used, having both rapidity of action and residual effect. From the observations that could be made upon the limited numbers of individuals involved, parathion appeared to be equally effective on both the green peach aphid and the *Macrosiphum* species present.

General Results

The Shafter plot location was almost ideal from an aphid control standpoint. The initial population level was not excessively high, and it was fairly uniform in its distribution throughout the plot area. This population increased rapidly and reached its peak about the time the third treatment application was made, and it remained at a high level for another week before declining rather slowly. Under these conditions the residual action of the three insecticides, DDT-sulfur, BHC, and parathion was pronounced and measurable. It also indicated the tendency for the DDT-sulfur dust to act slowly upon a rapidly increasing population, but when the population was checked, the lethal qualities of this dust were very apparent.

Nicotine was seen to act somewhat effectively in reducing the number of aphids, but a sufficient number of insects remained alive so as to nullify the beneficial effects of treatment.

At the Arvin location, the aphid population was lower initially and remained so throughout the period of sampling. The action of the various insecticides was not so clearly demonstrated under the Arvin conditions. With respect to population peak, it was a week or 10 days later than that of the Shafter area, and consequently, it involved a greater number of migrating alate insects during the first two weeks of dust application. The tendency expressed by the results obtained at this location appeared to indicate that although all the insecticides were effective as insecticides, they lacked residual effectiveness upon the incoming alate insects. The last population sample was taken the day following a severe wind storm, which accounts for the sharp reduction in insects at this time in all plots (table 4).

This location and population indicated that the reduction of an aphid population below a certain level is going to be a difficult problem, and that DDT-sulfur, BHC, and parathion are almost equally effective in attaining and maintaining a low population level. Whether or not, by the

application of insecticidal dusts, a population can be reduced below this relatively low level under the conditions of light but consistent alate movement remains to be determined, as well as whether or not a low level population is effective in virus disease spread.

DISCUSSION AND SUMMARY

Until recently, the available aphicides were inadequate to provide long lasting control since the materials deteriorated too rapidly after application to prevent reinfestation. Several of the newer materials (DDT-sulfur, BHC, and parathion) appear to retain sufficient toxicity to provide protection over a period of several weeks (table 4). An ideal aphicide for treatment of both commercial and seed fields of potatoes would be one which provides a rapid kill of the aphids present and maintains a very low population throughout the period of potential infestation and build up. Both BHC and parathion appear to approach this ideal. The deleterious odor imparted by BHC makes it impracticable to use on potatoes, whereas parathion and other organic phosphates should be used only with extreme caution because of their high toxicity to animals and man. The DDT-sulfur treatment, although not resulting in a rapid kill, would appear to provide satisfactory protection if it were applied early and frequently (table 4).

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THE MARYGOLD POTATO

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INTRODUCTION

On the Eastern Shore of Maryland two crops of potatoes are produced each year. The early crop is planted in March and harvested in July; the fall crop is planted in July and harvested in October or November.

Heretofore, it has been assumed that for table stock an early variety was necessary for the spring crop and a late variety for the fall crop. The Irish Cobbler variety was standard for spring planting and for fall planting for seed, and Dakota Red was standard for fall planting for table stock and seed. Seed potatoes for the late crop had to be held in cold storage to prevent severe sprouting and shrinking before planting time in July, which would result in poor stands and low yields.

When the cooperative potato-breeding work between the University of Maryland and the United States Department of Agriculture was started, a search was begun immediately to find or produce a variety that would outyield the Irish Cobbler in the spring planting and the Dakota Red in the fall planting. In addition, the tubers of the new variety would have to respond to chemical treatments to break the rest period so they could be planted immediately after harvest and produce a good stand.

A relatively large number of varieties and seedlings were tested on the Eastern Shore, but the first one to meet the requirements was Marygold. This variety, carried in the breeding plots as U. S. D. A. Seedling 47148, was first grown in Maine in 1932.

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In 1938 U. S. D. A. Seedling 47148 and a number of other varieties and seedlings were planted at Oakland, Maryland. The appearance of the vines and tubers of this seedling was so promising that it was increased for further study. These studies revealed that this seedling 47148 matured a little later than Irish Cobbler but yielded more. It also produced better stands and larger yields than those of any other variety or seedling when the tubers from the early crop were treated to shorten their rest period and used to plant the late crop on the Eastern Shore of Maryland. The name Marygold[1] was chosen for Seedling 47148, which is the second potato to be released in Maryland as a result of the potato-breeding program, the first being Potomac (3).[2]

DESCRIPTION

Plants.—Medium, spreading; stems thick, prominently angled; nodes slightly swollen, green; internodes much pigmented, reddish purple; wings much waved, slightly pigmented; stipules medium, green, and scantily pubescent; leaves long, open, and medium green; midrib green and scantily pubescent; primary leaflets narrowly ovate, medium, three or four pairs, mean length 72.14 ± 0.67 mm. (2.84 inches), mean width 41.23 ± 0.39 mm. (1.62 inches), index 47.29 ± 0.39; petioles green; secondary leaflets many, and in two positions, on midrib between pairs of primary leaflets, and at junction of midrib and primary leaflet petioles; tertiary leaflets many; inflorescence much branched, leafy bracts none; peduncles short to medium, green, and abundantly pubescent; pedicels medium long, green, and abundantly pubescent.

Flowers.—Calyx lobe tips medium long, green, and abundantly pubescent; corolla medium, color light blue with white tips (corresponding to Ridgway's light chicory blue (4); anthers orange-yellow; pollen abundant, good quality; style straight; stigma globose, multilobed, green.

Tubers.—Elliptical to roundish, mean length 87.7 ± 0.81 mm. (3.45 inches), mean width 79.0 ± 0.35 mm. (3.11 inches)[1] indexes; width to length 90.8 ± 0.96,[2] thickness to width 73.8 ± 0.54[3] thickness to length 66.9 ± 0.80;[3] skin smooth, eyes shallow, slightly purple; eye-

[1]The first part of the name is derived from Maryland and the second part from the flesh color of the tuber.

[2]Numbers in parentheses refer to order of literature cited.

[1]The average of measurements of 90 tubers with a mean weight of 224.6 ± 2.74 grams (7.92 ± 0.10 ounces).

[2]Calculated by dividing the widths of 90 tubers by their lengths and multiplying the average of these ratios by 100. The data for calculating the indexes were taken from the same measurements as those used to determine the dimensions of the tubers.

[3]Based on measurements of the same tubers as those used for determining the width to length index, using the same methods of calculation.

Pedigree of Marygold Potato

- **Marygold U. S. D. A. Seedling 47148**
  - Earlaine[1]
  - **U. S. D. A. Seedling 45208**
    - **U. S. D. A. Seedling 44043**
      - U. S. D. A. Seedling 42487
        - U. S. D. A. Seedling 24642
          - Sutton's Flourball
          - Aroostook Wonder
        - South America No. 327
      - U. S. D. A. Seedling 42464
        - Same parentage as 42487 above
        - Busola
    - **U. S. D. A. Seedling 43106**
      - U. S. D. A. Seedling 40568
        - Rural New Yorker No. 2
        - U. S. D. A. Seedling 24642
          - Sutton's Flourball
          - Aroostook Wonder
      - U. S. D. A. Seedling 41989
        - Yellow-flesh variety from Costa Rica

[1]The pedigree of Earlaine has been published by Clark and Stevenson (2).

brows medium long, curved, medium prominent; flesh light-yellow, corresponding to Ridgway's naphthalene yellow (4); sprouts when developed in the dark have base leaf scales and tips more or less suffused with purple; maturity early or mid-season.

ORIGIN

The Marygold potato has many desirable potato varieties in its ancestry such as Irish Cobbler, Earlaine, Sutton's Flourball, Triumph, Busola, Aroostook Wonder, and Rural New Yorker No. 2.[4] Its yellow flesh is derived from a yellow-flesh variety from Costa Rica. Its pedigree is given on the following page.

YIELD TESTS

Comparative yield tests have been conducted with the Marygold potato and other varieties at Oakland and Pocomoke, Maryland. Results of these tests are indicated in tables 1, 2, 3, and 4. It will be noted that at both Oakland and Pocomoke, Marygold significantly outyielded Irish Cobbler and Katahdin in a 5-year average but that at Oakland it did not yield as much as any of the late-maturing varieties when the field was sprayed with a fungicide. However, in a field sprayed with an insecticide only, during the same 5 years the average yield of Marygold did not differ significantly from that of Rural and Sebago. In this field, varieties susceptible to late blight were usually killed before they matured. Marygold vines were not resistant to late blight but were usually almost mature before blight became severe.

Studies conducted at Pocomoke have shown that the Marygold potato yields just as well as or better than Dakota Red when used for planting the late crop. Satisfactory results were obtained both from stored seed and from early-grown seed treated to shorten the rest period. In Maine Marygold was outyielded by Green Mountain and Chippewa for an average of 4 years but it outyielded Katahdin significantly. It is doubtful that Marygold will be grown in Maine for table stock, but if the demand for seed on the Eastern Shore increases, some of the growers in the North might find it to their advantage to grow certified seed of this variety. It is the opinion of the authors that the variety would be grown quite extensively on the Eastern Shore if a larger supply of seed were available. Results of tests conducted in Maryland and Maine are given in tables 1 to 4.

[4]Most of these varieties have been described by Clark and Lombard (1) and by Stuart (5).

TABLE 1.—*Comparative yields of Marygold and other potato varieties at Oakland, Maryland. Varieties harvested prior to September 1.**

Variety	1943	1944	1945	1946	1947	Average
	Yield in U. S. No. 1 Potatoes per Acre					
	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.
Marygold	270	64	263	277	306	236
Katahdin	277	33	212	192	265	201
Irish Cobbler	269	58	204	172	221	180
Difference for 5 per cent level of signi-cance	62	13	17	36	91	24

*Field sprayed 10 times with Bordeaux Mixture, 4-4-50. Three pounds of calcium arsenate were added to the mixture in 1943, 1944, and 1945. In 1946 and 1947, 1 pound of 50 per cent wettable DDT was added instead of calcium arsenate.

TABLE 2.—*Yields of early and late varieties at Oakland, Maryland harvested after vines died.**

Variety	1943	1944	1945	1946	1947	Average
	Yield in U. S. No. 1 Potatoes per Acre					
	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.
Sequoia	228	159	151	245	429	242
Potomac	198	104	98	325	387	222
Marygold	187	59	140	218	321	185
Rural	176	100	84	165	353	176
Sebago	141	79	73	220	351	173
Difference for 5 per cent level of significance	24	28	29	61	46	18

*Field sprayed with calcium arsenate 2-50 when Colorado potato beetles appeared in 1943, 1944, and 1945. Field sprayed 10 times with 1 pound of 50 per cent wettable DDT in 50 gallons water in 1946 and 1947.

TABLE 3. *Comparative yields of Marygold and other potato varieties at Pocomoke, Maryland.**

Variety	1943	1944	1945	1946	1947	Average
	Yield in U. S. No. 1 Potatoes per Acre					
	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.
Marygold	190	161	450	362	397	312
Katahdin	144	107	413	304	369	267
Irish Cobbler	159	146	281	273	223	216
Difference for 5 per cent level of significance	50	36	37	61	54	22

*Field sprayed 5 times with the same material used in Oakland plots.

TABLE 4.—*Comparative yields at Pocomoke, Maryland, from stored Dakota Red and Marygold Seed Potatoes and early-grown Marygold seed potatoes treated to shorten the rest period.*

Variety		Yield in U. S. No. 1 Potatoes per Acre 1944	1945	1947	Average
		Bus.	Bus.	Bus.	Bus.
Marygold	Home storage to April 1 Cold storage April 1 until planted	158	104	170	144
Marygold	Early crop cut pieces treated to shorten rest period	170*	77**	170†	139
Dakota Red	Home storage to April 1 Cold storage April 1 until planted	96	52	153	100
Dakota Red	Home storage during entire season	60	5	150	72
Difference for 5 per cent level of significance		39	46	66	30

*Soaked one hour in sodium thiocyanate, 1 per cent.

**Soaked one hour in ammonium thiocyanate, 1 per cent; followed by dip in Thiosan (active ingredient, tetramethyl thiuramdisulfide), 1 lb. per 4 gallons.

†Soaked one hour in ethylene chlorhydrin, 1 per cent.

QUALITY

In order to test the market quality of the Marygold potato approximately 250 bushels were sold in 1945[1] on the Baltimore and Washington markets. A self-addressed questionnaire was included in every package sold at retail. A summary of opinions follows:

Questionnaires returned:	96
Appearance of flesh:	Satisfactory, 77; objectionable, 17; yellow color, objectionable, 7.
Flavor:	Excellent, 58; satisfactory, 29; objectionable, 12.
Baking qualities:	Exceptional, 24; satisfactory, 24; poor, 12.
Cooking qualities:	Watery, 19 yes, 72 no; lumpy, 12 yes, 70 no.
Use for which potato most suitable:	Boiled, 39; mashed, 38; any use, 31; baked, 31; frying, 11; salad, 5; stew-

[1]Conducted in cooperation with R. P. Calloway, Marketing Specialist, University of Maryland.

TABLE 5.—*Yield and percentage of U. S. No. 1 tubers obtained from tests of the potato variety Marygold in comparison with standard varieties at Presque Isle, Maine.*

Variety	Yield U. S. No. 1 Tubers per Acre					Percentage U. S. No. 1 Tubers				
	1943	1944	1946	1947	Mean	1943	1944	1946	1947	Mean
	Bus.	Bus.	Bus.	Bus.	Bus.	Per cent	Per cent	Per cent	Per cent	Per cent
Marygold	475	278	341	553	412	98	98	98	99	98
Green Mountain	556	374	473	606	502	99	97	97	98	98
Katahdin	479	244	341	457	380	98	95	95	98	97
Chippewa	564	333	370	528	449	99	97	95	97	97
Difference for significance at 5 per cent level	63	33	54	35	24					

	ing, 4; cooking, 3; french fries, 3; boiled in jackets, 2; soup, 2; potato chips, 1; no use, 1.
Preference for Marygold to those used recently:	Yes, 60; no, 25.
Would purchase if more available:	Yes, 74; no, 21.

TABLE 6.—*Specific gravity tests of the potato variety Marygold in comparison with standard varieties at Presque, Isle, Maine.*

	Specific Gravity				
Variety	1943	1944	1946	1947	Mean
Marygold	1.086	1,081	1.083	1.077	1.082
Green Mountain	1.100	1.086	1.099	1.088	1.093
Katahdin	1.087	1.077	1.093	1.079	1.084
Chippewa	1.079	1.073	1.080	1.074	1.077

Cooking tests were conducted by the specialist in nutrition[1], and the report received follows:

"Marygold is a good all-purpose potato. It is a very good baker, is good also steamed and boiled, both in the jacket and pared. It gives a nice golden-brown potato chip and french fries that are tender and fairly crisp. The potato is especially good baked, mashed, escalloped, steamed, and boiled, and fairly good for salads. It is very tender and has a nice mild flavor and a rich golden color in all of these dishes."

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[1]Conducted in cooperation with Margaret McPheeters, Associate Professor of Nutrition, University of Maryland.

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EFFECTS OF STORAGE ON STARCH AND SUGARS CONTENTS OF MAINE POTATOES

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Large surpluses of potatoes in 1943 and 1946 have spurred efforts to expand non-food outlets, such as starch manufacture. In the manufacture of potato starch and in other potato processing, it is necessary to store potatoes for several months in order to extend the operating season. Although many investigations have been carried out on potato storage, most of this work has dealt with the determination of proper storage conditions for table stock and seed potatoes. There is a real need for information on the storage of potatoes to be used in industrial processes. Operators of starch factories, for example, have noted that potatoes yield less starch in late winter and spring after storage at a relatively low temperature. Although no supporting data are available, they believe that starch produced late in the operating season is of lower quality than

***One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.**

that obtained from freshly dug potatoes. Published reports show that storage at low temperatures decreases the percentage of starch and increases the percentage of sugars in potatoes, but it was considered desirable to obtain similar data on the types of potatoes commonly used in starch manufacture and to compare the quality of commercial starch produced from potatoes early in the season with that of starch from stored potatoes.

The two most popular varieties of potato grown in Maine—the Katahdin and the Green Mountain—were selected for the storage experiments, since most of the potatoes processed into starch in Maine are of these varieties. The potatoes were stored at temperatures ranging from 34° to 60° F. According to Stuart *et al.* (11), the temperature of a potato storage house in Aroostook County, Maine, ranges from 34° to 45° F. during the winter. Heat is supplied during extremely cold weather to prevent freezing, and increased ventilation with outside air is employed during mild weather to offset heat of respiration.

REVIEW OF THE LITERATURE

The most important chemical changes occurring during the storage of potatoes are in the starch and sugars. Müller-Thurgau (7) reported in 1882 that the sugar content of potatoes increased during cold storage or on slow freezing. This investigator also observed that when potatoes were taken from cold storage and exposed to a higher temperature (68° F.) the sugar content decreased. According to Appleman (1), three processes occur in a potato: (a) respiration, which consumes sugar by converting it into carbon dioxide and water; (b) conversion of starch to sugar by amylolytic enzymes; and (c) conversion of sugar to starch ,presumably by starch-synthesizing enzymes). At low temperatures sugars increase and starch decreases; at higher temperatures, sugars decrease as a result of respiration and starch synthesis. Potatoes lose weight in storage, owing partly to evaporation of water and partly to respiration. Many investigators, including Hopkins (5), Barker (3), Kimbrough (6), and Smith (9), have studied the factors influencing rate of respiration.

Research workers in the Bureau of Plant Industry, Soils, and Agricultural Engineering have contributed to the potato-storage literature during the past 15 years. In a study on the influence of storage conditions on respiratory and other physiological changes, carbohydrate composition, and culinary quality of potatoes, Wright, Peacock, Whiteman and Whiteman (13) found that the percentage of starch decreased with decrease in storage temperature and that the sugar content increased in a commensurate amount. Wright (14) measured the decrease in content

of sugars accumulated during 5 months' storage at 32° F., after transferral of the potatoes to 60° storage. Wright, Caldwell, Whiteman and Culpepper (12), who recently investigated the effect of storage conditions on the quality of dehydrated potatoes, concluded that accumulation of sugars during low-temperature storage results in a sweet, soggy and badly discolored potato.

Denny and Thornton (4) have pointed out that the amount of sugars formed during cold storage of potatoes depends on variety as well as temperature. They likewise found that the extent of de-sugaring which occurs on exposure to higher temperatures is different in different varieties.

Barham, Kramer, and Reed (2) studied the changes in weight and in starch content of potatoes during 6 months (July to January) of cold and shed storage in Kansas. In this period the starch content fell from 14.7 to 9.6 per cent in cold storage and to 10.3 per cent in shed storage.

Materials and Methods

U. S. No. 1 Katahdin and Green Mountain potatoes of the 1945 crop were used in this study. The potatoes were grown at the Aroostook Farm of the Maine Agricultural Experiment Station, Presque Isle, on Caribou loam, fertilized with one-half ton per acre of fertilizer (2N—$4P_2O_5$—$5K_2O$) containing 1 per cent magnesium. The vines were sprayed with Bordeaux mixture (5 Ca $(OH)_2$-5 Cu $(SO_4)_2$-50 water) six times during the season. The vines were also sprayed with calcium arsenate solution, 2 pounds per 100 gallons of water. Except for a slight amount of leaf roll, disease in the potatoes was non-existent. Temperature and moisture were normal up to the 1st of August at Aroostook Farm, but a dry August produced smaller potatoes than usual. The potatoes were harvested on the 27th of September and held for 5 days at 50° to 60° F. after harvesting.

The storage boxes held 55-60 pounds of potatoes and were ventilated through slots about ¾ inch wide, placed at the bottom of one side and top of the opposite side. Care was taken in mixing and in distributing the potatoes in order to obtain uniform samples.

On the 2nd of October the potatoes were weighed, sampled, and then placed in storage bins at Aroostook Farm at the following temperatures and relative humidities: 34° F. and 81 per cent R. H.; 36° F. and 83 per cent R. H.; 38° F. and 82 per cent R. H.; 42° F. and 82 per cent R. H.; 50° F. and 87 per cent R. H.; 60° F. and 68 per cent R. H. Duplicate boxes of each variety were placed in each storage bin, one to serve as a source of samples and the other as a weight control. After 7,

13, 22, 29 and 37 weeks the potatoes were examined, weighed, and sampled. Each time duplicate three-pound samples (about 10 potatoes) were removed from each box for analytical determinations. One sample was finely ground (with a high-speed rasp or hammer mill), moisture was determined, and a portion was immediately preserved in alcohol for later analysis at the Eastern Regional Research Laboratory, where all other determinations were made. Sufficient absolute alcohol was used to give a final concentration of approximately 80 per cent alcohol after dilution with the potato juice. The alcohol-insoluble solids were used for the starch determination. It was necessary to determine sugars only in the alcoholic extract. When approximately 90 grams of finely ground potato were allowed to stand in 360 cubic centimeters of absolute alcohol for 1 week or longer at room temperature before analysis, practically all the sugars leached out into the 80 per cent alcohol. The duplicate set of samples was kept for about 2 weeks at ordinary temperatures (60°—70° F.) , then ground and immediately analyzed.

Moisture was determined by drying a 15 to 20-gram sample of ground potato, spread thinly over the bottom of a shallow dish, in an oven at 120-°-135° F. for 4 to 6 hours and then at 275° F. for 2 hours. Starch was determined polarimetrically by the Steiner and Guthrie method (10). Sugars were determined by the official gravinometric methods (8) of the Association of Official Agricultural Chemists.

DATA AND RESULTS

Table 1 shows the changes in starch content during storage at the various temperatures and after 2 weeks at room temperature following removal from cold storage. The loss of starch was considerable at the lower temperatures 34°, 36°, and 38° F. At higher temperatures the change was less. The Katahdin potatoes changed little in starch content after 7 weeks' storage. The Green Mountains, however, continued to lose starch up to the thirteenth week of storage. After the potatoes were withdrawn from cold storage and kept at room temperature for 2 weeks or longer, the values for starch increased, approaching, on a percentage basis, the original value. The Green Mountain variety showed this tendency more definitely than the Katahdin variety.

It will be noted that some of the starch values for the Green Mountains, on the wet basis, are higher than the original starch content, undoubtedly owing to unusual loss of moisture. On the dry basis, however, no values exceed the original beyond the expected experimental error.

The changes in sugar content are given in table 2. A large increase in total sugars (primarily in reducing sugar) was found in potatoes stored at 34° and 36° F. The greatest change took place during the first 13 weeks

TABLE I.—*Changes in starch content of potatoes during storage at various temperatures*[a]

Storage Temperature, °F.	Starch Content after Storage of (Weeks)—					Starch Content after 2 Weeks at Room Temperature Following Withdrawal from Storage of (Weeks)—				
	7 Per cent	13 Per cent	22 Per cent	29 Per cent	37 Per cent	7 Per cent	13 Per cent	22 Per cent	29 Per cent	37 Per cent
	Katahdin (Original Starch Content 13.5 per cent (72.3).)									
34	9.7 (56.1)	10.3 (54.5)	9.6 (55.9)	9.8 (55.2)	9.9 (56.2)	12.1 (64.2)	12.4 (63.2)	13.1 (66.5)	10.4 (57.9)	10.8 (60.3)
36	10.9 (60.9)	9.6 (56.9)	10.2 (59.6)	10.1 (58.2)	9.7 (56.9)	12.7 (65.8)	12.8 (64.2)	12.5 (65.3)	10.6 (56.1)	12.2 (64.3)
38	11.5 (62.8)	11.3 (63.6)	11.1 (64.4)	—	11.2 (61.1)	12.9 (68.9)	13.4 (66.0)	13.0 (66.4)	12.0 (62.9)	11.4 (63.3)
42	11.9 (65.7)	12.1 (67.3)	11.5 (67.5)	—	12.0 (66.1)	13.6 (71.5)	13.1 (67.7)	12.6 (66.2)	12.5 (61.4)	13.6 (66.5)
50	11.9 (66.1)	12.6 (68.9)	12.1 (68.9)	12.1 (71.7)	--b/	13.0 (69.7)	13.4 (66.9)	13.4 (68.1)	11.4 (58.6)	--b/
60	12.8 (71.1)	13.2 (73.6)	12.0 (68.4)	12.1 (62.9)	--b/	13.3 (69.9)	13.3 (64.0)	13.8 (65.6)	13.8 (56.9)	--b/
	Green Mountain (Original Starch Content: 15.6 per cent (73.3).)									
34	13.0 (69.0)	11.4 (58.8)	12.5 (62.7)	11.8 (60.0)	12.1 (61.5)	15.2 (71.3)	15.1 (71.7)	14.9 (70.1)	14.6 (70.1)	15.6 (71.1)
36	14.1 (70.8)	12.4 (63.5)	12.3 (62.9)	13.4 (66.9)	11.7 (61.1)	15.5 (71.5)	13.6 (66.8)	16.5 (73.4)	15.3 (72.1)	15.3 (70.2)
38	15.0 (73.9)	13.9 (69.3)	13.1 (67.0)	13.6 (70.2)	13.8 (67.1)	15.9 (74.1)	15.7 (72.7)	16.2 (72.3)	14.6 (68.1)	16.8 (71.1)
42	16.8 (78.9)	14.1 (71.6)	12.7 (68.1)	14.4 (70.8)	15.7 (72.7)	15.9 (73.3)	16.5 16.2	16.1 (73.6)	15.8 (71.9)	17.1 (71.4)
50	16.6 (81.8)	14.6 (72.1)	15.2 (70.8)	14.7 (73.1)	--b/	15.7 (73.5)	(73.9) (73.8)	16.4 (73.4)	17.6 (74.0)	--b/
60	16.6 (80.2)	15.4 (73.4)	14.8 (70.5)	14.7 (66.0)	--b/	16.0 (73.4)	16.2 (73.5)	17.5 (73.4)	17.1 (60.0)	--b/

a. Figures in parenthesis are on dry basis.
b. No determinations made. Sprouted too extensively to be utilized for any purpose.

TABLE 2.—*Changes in sugars Content of potatoes during storage at various temperatures*[a]

Storage Temperature, °F.	Total Sugars, Content after Storage for (Weeks)— 7	13	22	29	37	Reducing Sugars, Content after Storage for (Weeks)— 7	13	22	29	37
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Katahdins (Original Content: Total Sugars, 0.33 per cent (1.76); Reducing Sugars, 0.1 per cent (0.56).)										
34	1.8	3.2	2.5	2.4	3.1	1.4	1.9	1.8	1.5	1.9
	(8.5)	(17.1)	(14.8)	(13.5)	(17.5)	(8.0)	(10.0)	(10.9)	(8.1)	(10.5)
36	1.2	2.6	2.6	2.1	2.1	1.4	1.8	1.9	1.6	1.5
	(7.0)	(15.3)	(15.3)	(13.4)	(12.2)	(7.9)	(10.3)	(10.9)	(8.9)	(8.7)
38	0.8	1.5	1.2	—	1.0	0.8	1.1	0.9	—	0.8
	(4.5)	(9.0)	(6.8)		(5.3)	(4.6)	(6.4)	(5.5)		(4.4)
42	0.4	0.5	0.6	—	0.3	0.3	0.1	0.3	—	0.3
	(2.1)	(2.6)	(3.6)		(1.8)	(1.7)	(0.5)	(1.7)		(1.5)
50	0.2	0.25	0.3	0.3	—b/	0.1	—	0.1	0.2	—
	(0.9)	(1.2)	(1.7)	(1.9)		(0.6)	c/	(0.7)	(0.9)	b/
60	0.2	0.2	0.3	0.6	—b/	0.1	—	0.1	0.4	—
	(1.0)	(1.1)	(1.7)	(2.9)		(0.6)	c/	(0.8)	(1.9)	b/
Green Mountain (Original Content: Total Sugars, 0.60 per cent (2.9); Reducing Sugars, 0.24 per cent (1.1).)										
34	2.9	3.3	2.6	2.5	2.3	1.7	2.1	1.6	1.8	1.8
	(14.4)	(16.7)	(13.0)	(12.7)	(11.9)	(8.4)	(10.8)	(8.1)	(9.0)	(9.1)
36	2.1	2.7	2.0	1.8	2.3	1.5	1.9	1.5	1.3	2.0
	(10.8)	(13.7)	(10.5)	(8.8)	(12.2)	(7.5)	(9.5)	(7.6)	(6.6)	(10.5)
38	1.6	1.8	1.0	1.2	1.3	1.1	1.3	1.2	1.0	1.1
	(8.0)	(9.2)	(4.9)	(6.4)	(6.4)	(5.3)	(6.6)	(6.0)	(5.0)	(5.3)
42	0.6	0.9	0.7	0.7	0.6	0.4	0.4	0.6	0.5	0.5
	(2.8)	(4.3)	(3.7)	(3.6)	(2.7)	(2.0)	(2.0)	(3.2)	(2.6)	(2.3)
50	0.6	0.7	0.4	0.6	—	0.35	0.2	0.3	0.6	—
	(2.9)	(3.3)	(1.6)	(2.8)	b/	(1.7)	(0.9)	(1.1)	(3.1)	b/
60	0.4	0.5	0.4	1.3	—	0.3	0.1	0.3	0.7	—
	(2.0)	(2.5)	(1.8)	(5.9)	b/	(1.4)	(0.5)	(1.3)	(2.9)	b/

a. Figures in parenthesis are on dry basis.
b. No determinations made. Sprouted too extensively to be utilized for any purpose.
c. Only trace present.

of storage. During the next 24 weeks the changes were less significant. At storage temperatures of 38° and 42° F., the increase in both total and reducing sugars was slight, and at 50° and 60° F. there was even a slight reduction in the amount of total sugars, particularly in the Kathadin variety.

As a general rule, the values for both reducing and total sugars of potatoes from cold storage decreased decidedly after 2 weeks' exposure to ordinary temperatures. Katahdins stored at 34° F. and sampled after 7, 13, and 22 weeks, for example, contained 8-½ to 17 per cent total sugars, as shown in table 2. (Data on the dry basis are discussed here to facilitate comparisons). Table 3 shows that the total sugars content was reduced to 5-6 per cent after these potatoes were removed to room temperature. Likewise the total sugars contents of the Katahdins stored at 36° and 38° decreased to 7-15 and 4½—9 per cent, respectively to about 3-4 per cent. At 42°, the moderately low sugar contents remained about the same during the after-storage period. At 50° and 60°, the sugar contents actually increased. For example, Katahdins kept at 60° for 29 weeks contained 5.9 per cent total sugars, which increased to 7.8 per cent in the following 2 weeks. The potatoes which increased in sugar content sprouted considerably during this period; increase in sugar is believed to be associated with extensive sprouting, as pointed out in the discussion of table 5.

TABLE 3.—*Total sugars content of potatoes kept at room temperature for about 2 weeks after removal from cold storage*[a, b].

(*Same samples as in table 2*)

Storage Temperature, °F.	Katahdin			Green Mountain		
	Total Sugars Content after Storage for (Weeks)			Total Sugars Content after Storage for (Weeks)		
	7 Per cent	13 Per cent	22 Per cent	7 Per cent	13 Per cent	22 Per cent
34	1.1 (5.9)	1.0 (5.1)	1.0 (4.8)	0.6 (3.9)	0.8 (3.6)	0.7 (3.2)
36	0.9 (4.5)	0.8 (4.2)	0.8 (4.0)	0.5 (2.4)	0.7 (3.7)	0.7 (2.9)
38	0.6 (3.4)	0.7 (3.3)	0.7 (3.8)	0.5 (2.2)	0.6 (3.0)	0.7 (3.0)

a. Original sugar contents the same as in sugar table 2.
b. Figures in parenthesis are on dry basis.

On removal from cold storage, the Green Mountain potatoes behaved about the same as the Katahdins. Table 3 shows that the Green Mountain variety, although it originally developed more total sugars than did the Katahdins, reached even slightly lower sugar values during reconditioning. Like the Katahdin variety, the Green Mountain potatoes lost only a small amount of their relatively low sugar contents on removal from storage at 42° to room temperature. There was an appreciable gain in sugar content during the 2 weeks following storage at higher temperatures. The Green Mountains kept at 60° for 29 weeks increased from 5.9 to 13.3 per cent in total sugars during the 2 weeks after storage.

It will be seen that the sum of corresponding values for starch and total sugars (both on the dry basis) in tables 1 and 2 gives total carbohydrates (minus cellulose and hemicellulose). These total values remain reasonably constant. Total carbohydrate values of potatoes after 2 weeks at room temperature following storage also agree well with those of potatoes taken directly from storage.

The Katahdins contained 74 per cent total carbohydrates on the dry basis at the time of entering storage. The percentages of total carbohydrate (averages for the entire storage period) were as follows: 34° F.—70 per cent at time of removal from storage bin and 69 per cent after 2 weeks of secondary storage; 36°—71 and 68 per cent; 38° F.—69 and 69 per cent; 42° F.—69 and 69 per cent; 50° F.—70 and 68 per cent; 60° F.—71 and 67 per cent. These data show little variation. There is, however, a drop from the original value, for which there is no ready explanation.

The Green Mountain potatoes contained 76 per cent total carbohydrates on the dry basis originally and, as the following average data show, there was little deviation at the various temperatures: At 34° F.—76 per cent at time of removal from storage and 74 per cent after 2 weeks at ordinary temperature following storage; at 36° F.—76 and 74 per cent; at 38° F.—77 and 75 per cent; at 42° F.—76 and 76 per cent; at 50° F.—77 and 76 per cent; at 60° F.—76 and 75 per cent.

The foregoing results show that under different conditions of storage an increase of sugars is accompanied by a corresponding decrease in starch, and *vice versa.* These data, however, do not take into consideration loss in weight during storage. The potatoes lost about 5 per cent of their original weight in 37 weeks' storage at 34° F., 5-½ to 6-½ per cent during the same period at 36° F., and about 7 per cent at 42° F. At 50° F., 6 to 6-½ per cent of the original weight had been lost at the end of 29 weeks; at 60°, the loss was 17 to 18 per cent during the same time.

It is of interest to know the loss in weight of starch and starch plus sugars occurring during storage. Table 4 shows loss of weight after storage at 34°, 36° and 42° F. for 13 and 37 weeks. Data for temperatures higher than 42° are omitted because they are of minor interest, owing to the fact that the temperature of Maine storage houses generally does not exceed this value.

TABLE 4.—*Loss in weight of starch and starch plus sugars during storage of Katahdin potatoes.*

Temperature Storage °F.	Loss of Starch During Storage for (Weeks)--		Loss of Starch Plus Sugars During Storage for (Weeks)--	
	13 Per cent a/	37 Per cent a/	13 Per cent a/	37 Per cent a/
34	24.3	29.1	15.8	19.4
36	29.4	31.6	12.9	17.9
42	11.3	15.6	10.4	15.6

a. Based on original content.

The conditions under which it was necessary to work in this study did not provide sufficient precision, especially in weighing, to permit determining differentially the amounts of sugar lost in respiration and consumed in synthesis to starch while the potatoes were held at room temperature after cold storage. Data taken at this Laboratory on other potatoes, however, show that sugars which disappear during reconditioning are converted at least partly into starch.

With the exception of the moisture content of potatoes which sprouted extensively, moisture content did not vary much from the original values. The moisture content of the potatoes held in storage for 29 weeks at 60° F. dropped only 1 to 1-½ per cent. Loss of weight, therefore, was generally distributed between water and solids in about the same proportion as in the original composition.

The Katahdin potatoes began to sprout in 7 weeks at 60° F. and soon afterward at 50° F.; incipient sprouting in this variety appeared after 13 weeks at 42° F. The Green Mountain potatoes stored at 50° and 60° F. started to sprout during the 13-week period. At 38° F., sprouting started in both varieties after 29 weeks but did not occur below this temperature even at 37 weeks. Sprouts were 1 to 2 feet long after 29 weeks' storage at 50° and 60° F., and the tubers were soft and shrunken. Katahdin potatoes in this condition were used to determine the composition of both the sprouts and the tubers. Although the sprouts constituted a minor fraction of the whole potato, table 5 shows that most of the reducing sugar was present in them. Total sugars were about equally divided between the two fractions. The sprouts fraction contained only a small amount of starch.

Although there are no generally accepted specifications for potato starch, the starch trade recognizes the following values as desirable: High degree of whiteness, low content of cold water-soluble material, low acidity, pH near 7, ash content about 0.35 per cent, low nitrogen content, and relatively high viscosity. Accordingly, these properties of starches produced in Maine factories in the fall of 1945 were compared with those of starches produced in the same factories in the spring of 1946. It was found that starch from the stored potatoes was essentially of the same

TABLE 5.—*Analysis of Katahdin tubers and sprouts after storage at 60° F. for 29 weeks.*

	Tubers		Sprouts	
	Based on Fraction	Based on Whole Potato	Based on Fraction	Based on Whole Potato
	Per cent	Per cent	Per cent	Per cent
Starch	15.4	13.1	3.1	0.5
Total sugars	0.37	0.31	2.58	0.39
Reducing sugars	0.1	0.1	2.55	0.38

Tuber fraction = 85 per cent by weight of whole sprouted potatoes. Moisture, 78.6 per cent.

(Sprouts fraction = 15 per cent by weight of whole sprouted potatoes. Moisture 90.7 per cent.)

quality as that from freshly harvested potatoes. Starches produced in 19 factories in the fall of 1945 and the spring of 1946, had the following average values: Whiteness (Measured with a G. E. automatic recording spectrophotometer; reflectance at 450 mu wave length compared to magnesium oxide at 100 was used), 82.5 and 82.2 respectively; cold water-soluble material, 0.25 and 0.23 per cent; acidity equivalent to 19.1 and 16.9 cubic centimeters of 0.1 normal sodium hydroxide per 100 grams starch; pH (measured with an electrometer; suspension of 1 gram starch in 5 grams water was used), 6.5 and 6.1; ash, 0.36 and 0.35 per cent; nitrogen, 0.01 and 0.02 per cent; viscosity of 2 per cent paste at 194° F., 572 and 615 centipoises.

DISCUSSION

From the point of view of the food consumer there is little loss in the food value (carbohydrate contents) of potatoes kept in cold storage. Growers who store their potatoes and later sell on a weight basis, however, will have to take into consideration the loss in weight. Shippers, dealers, and distributors who buy and sell potatoes must make allowance

for loss in weight, although their total percentage of carbohydrates remains practically unchanged. Potatoes kept in cold storage for 2 to 3 months contain only about 70 per cent of their original starch. If potatoes are to be processed for production of alcohol or other fermentation product in which conversion to sugar is the first step, or are to be hydrolyzed to crude glucose syrup, then stock taken directly from cold storage should be acceptable.

Sprouts are considered objectionable because they cause difficulties in washing the potatoes; starch manufacturers generally insist that they be removed prior to acceptance of the potatoes. Little starch is lost by their removal.

Summary and Conclusions

The effects of storage at 34° to 60° F. on the composition of potatoes was studied. The total carbohydrate content changed but little. Loss of carbohydrate material and of moisture occurred at about the same rate, so that the percentage of solids remained nearly at the original level. Potatoes removed from cold storage and kept for 2 weeks or more at ordinary temperatures increased in starch content. Potato sprouts contained little starch but a relatively large percentage of sugars. Commercial starch produced from stored potatoes in the spring of 1946 had essentially the same quality as that from freshly harvested potatoes in the fall of 1945.

Acknowledgment

The authors wish to acknowledge the splendid cooperation and help given by staff members of the Maine Agricultural Experiment Station during the course of this work. In particular we wish to thank Dr. Fred Griffee, Director and S. O. Hanson, Superintendent of Aroostook Farm, who placed the facilities of the Station at our disposal, and Michael Goven, who supervised the storage bins.

Determinations of whiteness of starch samples were made by Dr. Margaret L. Swain and nitrogen determinations were made under the direction of Dr. C. O. Willits, both of this Laboratory.

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THE SARANAC POTATO: A NEW VARIETY PROMISING IN AUSTRALIA

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ORIGIN

The Saranac potato, U.S.D.A. Seedling No. 336-144, was one of a number of seedlings and varieties sent to the Department of Agriculture, Sydney, Australia, in 1938. This is in keeping with the policy of the U.S.D.A. to send plant materials to foreign countries in exchange for varieties of foreign origin. Seedling 336-144 has been very promising in certain sections of Australia, and the Department of Agriculture at Sydney has requested that it be named so that it may be entered on their certified potato lists and distributed to growers.

Saranac was produced in 1932 from seed at Presque Isle, Maine. It was a selection from a cross of President x Katahdin. President has been called by several names in the United States. It was first described by Bonde as Foster's Rust Proof (1). It was later called No Blight, and still later identified as President. Clark and Lombard (3) have given four synonyms for President: Paul Krüger, President Krüger, No Blight, and Rust Proof. Although President is very late maturing and is moderately resistant to late blight, it is of no commercial value in the United States, for it usually produces only a small crop of U. S. No. 1 tubers. Katahdin is the most widely grown late variety of potato in the United States. It is grown extensively also in the Maritime Provinces of the Dominion of Canada.

DESCRIPTION

Plants.—Large size, erect; stems medium thick, slightly angled; nodes slightly swollen, green; internodes green; wings slightly waved; stipules medium size, green, scant pubescence; leaves medium length and width; midrib green, sparsely pubescent; primary leaflets three or four pairs, ovate, medium size, mean length of blade 56.4 mm, mean width 29.2 mm, index 51.8; leaflet petioles green; secondary leaflets few in number, between pairs of primary leaflets; tertiary leaflets none.

Flowers.—Inflorescence little branched; leafy bracts none; calyx

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lobes medium long, green, sparsely pubescent; corolla medium size, white; anthers orange yellow; pollen medium in quantity and quality; style straightt; stigma flattened globose, not lobed, green.

Tubers.—Round; mean length 83.1 mm., mean width 79.5 mm., mean thickness 61.8 mm; indexes, width to length 95.6; thickness to width 77.7; thickness to length 74.4; skin flaked, self-colored, ivory yellow; eyes shallow, same color as skin; eyebrows medium long and medium prominent; flesh white; maturity late.

CHARARTERISTICS

The cross between President and Katahdin was made as a part of a study of the inheritance of resistance to late blight. From this cross 467 selections were tested for resistance to this disease in the greenhouse at Arlington Farm, Virginia, in the spring of 1934 (4). About one-third of them showed as much resistance to late blight as the President. Saranac was one of these. In the field tests in Maine where the plants were sprayed with a suspension of blight spores the reaction of this variety to late blight varied somewhat in 9 years' tests but for any given year it always showed an intermediate type of resistance quite similar to that of the President parent.

Saranac was found to be resistant to ring rot, *Corynebacterium sepedonicum* (Spieck and Kott). Skap. and Burk., as shown by Bonde *et al.* (2). In tests where it was severely infected with the organisms causing this disease it contracted very little disease for four successive years. In contrast, susceptible varieties like Katahdin and Green Mountain developed a high percentage of infection and did not survive the test for more than one year.

It has been used as a parent in the United States because of its ring-rot resistance and some of the progeny of crosses, in which it was one of the parents, have shown a degree of resistance to brown rot or Southern bacterial wilt.

It is too late maturing for most of the potato-growing sections of the United States. It has shown the greatest promise in Franklin County, New York, and for several years it was considered for introduction in that state. However, it was found to be so susceptible to leaf roll in both New York State and Maine that it was decided not to increase and distribute it in the United States.

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THE EFFECT OF TIME OF HARVEST, VARIETY, AND STORAGE OF THE ASCORBIC ACID CONTENT OF POTATO TUBERS

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INTRODUCTION

A program of breeding potatoes for a higher asorbic acid (vitamin C) content is necessarily based on accurate evaluation of the material under study. Accurate evaluation of varieties as sources of ascorbic acid is possible only when the effects of other factors which might influence ascorbic acid content are known. Some of the more obvious of these factors are stage of maturity, environmental factors in the field, storage conditions, and their interactions. The data herein reported are from a preliminary study of the influence of such factors.

Numerous investigators have reported varietal differences in the ascorbic acid content of potato tubers, and no attempt is made to present a review of all the papers on the subject. Karikka, Dudgeon, and Hauck (1) reported significant varietal differences, with Katahdin having a high ascorbic acid content and Chippewa having a low. Murphy, Dove, and Akeley (3) reported a similar relation between these two varieties.

A steady decline of the ascorbic acid content of potatoes during storage has been reported by Thiessen (7), Wachholder (8), and others. Smith and Patterson (6) found that potatoes in cold storage were higher in ascorbic acid content than those stored at room temperature. On the other hand, Karikka, *et al.*, (1) observed that potatoes stored at 50°F. lost less ascorbic acid than those stored at 40°F. Lampitt, Baker, and Parkinson (2) reported that the asorbic acid in potato tubers declined steadily until January and then remained about constant. Also there was no difference in storage losses of ascorbic acid with potatoes grown at different locations.

Smith and Gillies (5) and Smith and Paterson (6) in England stated that the ascorbic acid content of potato tubers increased until August and then began to decline as the tops died. Lampitt, *et al.* (2) found no change in the ascorbic acid concentration of potato tubers after the tubers were well formed. Murphy, *et al.* (3) found that a group of late-maturing varieties had a higher ascorbic acid content than a group of early-maturing varieties. In the latter case, all varieties were harvested at the same time, *i.e.* some time after the

early varieties had matured. They concluded that the difference may have been due to the immature condition of the late-maturing varieties.

Procedure

The potatoes used in this experiment were obtained from the commercial fields of Richard Amidon, a potato grower at Lafayette, New York. The Irish Cobbler and Warba varieties were grown in the same field. The Chippewa, Pontiac, and Sebago varieties were obtained from a different field, and the Katahdin variety was grown in a third field. All the fields were in the same general area on Ontario loam at an elevation of about 1700 feet. All varieties were planted from the 26th to 29th of May, 1946, and the fields were fertilized with about one ton of 5-10-5 per acre. The usual fungicidal spray program was followed and DDT was used to control insects.

Samples were taken for analysis on the 31st of August, the 16th of September, and the 2nd of October, 1946. On the first two dates a random sample of ten hills was harvested from each field. The weight of tops and tubers and number of tubers was recorded for each hill. The Chippewa field was sprayed with a vine-killer (Dow 66 Improved) on the 11th of September, and the tops were completely dead at the time of the second harvest. The Katahdins were sprayed on the 15th of September, but there was little damage to the tops at the time of the second harvest. The vines of Warba and Irish Cobbler were completely dead at the second harvest and it was impossible to determine accurately individual hills; therefore, no yield data were obtained. At the last date, all varieties with the exception of Sebago had been harvested the previous week by the grower, and two bushels of each variety were selected from the storage bins. A two-bushel sample of Sebago tubers was dug on the 2nd of October. At the laboratory, the tubers were washed and placed in storage at 40°F. until they were analyzed (not more than two days after digging). At each harvest date, twenty tubers of each variety were analyzed individually for ascorbic acid. The percentage dry weight of each tuber was obtained at the same time.

For the storage study, a number of ten-tuber samples of each variety were stored in open paper bags at 40°F. until analyzed for ascorbic acid. Upon removal from storage, two median longitudinal slices, each weighing about 20 grams, were cut from each tuber. One was dried in a forced-draft oven at 70°C. for 48 hours to obtain the dry weight. The other slice was used for the determination of ascorbic acid by the method described by Nelson and Somers (4). Previous experiments indicated that the ascorbic acid content of a medium

longitudinal slice was the same as the ascorbic acid content of the whole tuber.

The standard error of each mean was calculated and the significance of differences was determined by Student's "t". Odds greater than 19:1 were considered significant.

Result and Discussion

The data obtained at each harvest are presented in table 1 and figure 1. The data concerning the vegetative growth of the plants in the field (the weight of tops and tubers) are presented to serve as an indication of the maturity of the plants at each date of harvest. The tubers were considered mature when the tops were dead and the periderm of the tubers did not "skin" with the usual handling. The Warba and Irish Cobbler tubers were mature at the first harvest. Pontiac, Katahdin, and Chippewa were mature at the second harvest or shortly afterward as a result of spraying with a vine-killer. The Sebago plants were still green and in good condition at the third harvest. During the period of study only the Sebago variety showed an appreciable increase in yield of tubers.

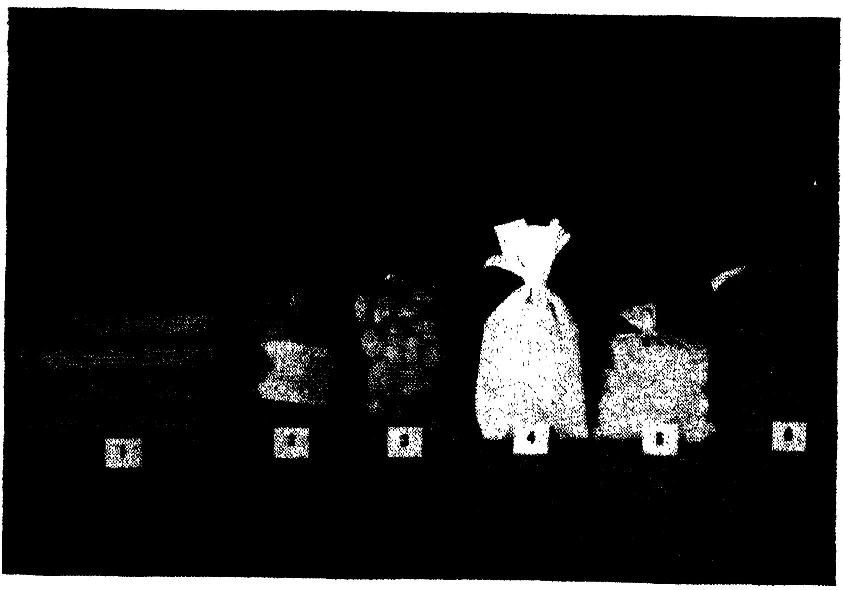

Fig. 1. Containers used in Potato Storage Experiment. Left to right: Crate. 2. Saxolin. 3. Chasenet. 4, Paper. 5. Cotton. 6. Burlap.

TABLE I.—*The effect of date of harvest on the ascorbic acid content of several varieties of potatoes stored at 40°F.*

(*Mean ascorbic acid content as mg. per 100 gms. fresh weight at the time of analysis ± the standard error.*)

Variety	Date of Harvest	Days in Storage: 0	12 - 16	32	50	64 - 66	84	98
Warba	Aug. 31	32.3 ± 0.96	24.2 ± 1.71	19.8 ± 0.76	- - - - -	9.5 ± 0.44	- - - - -	- - - - -
	Sept. 16	25.1 ± 1.35	25.0 ± 0.82	- - - - -	13.9 ± 0.85	- - - - -	8.4 ± 0.59	- - - - -
	Oct. 2	22.1 ± 1.14	26.0 ± 1.14	14.5 ± 0.81	- - - - -	11.0 ± 0.29	- - - - -	8.8 ± 0.19
Irish Cobbler	Aug. 31	28.4 ± 0.99	24.3 ± 0.86	17.3 ± 0.69	- - - - -	11.5 ± 0.39	- - - - -	- - - - -
	Sept. 16	24.4 ± 1.13	18.8 ± 0.78	- - - - -	12.4 ± 0.33	- - - - -	7.5 ± 0.32	- - - - -
	Oct. 2	22.0 ± 0.66	24.9 ± 0.83	14.1 ± 0.32	- - - - -	11.4 ± 0.38	- - - - -	8.4 ± 0.21
Chippewa	Aug. 31	22.3 ± 0.80	19.0 ± 0.75	14.8 ± 0.42	- - - - -	11.1 ± 0.35	- - - - -	- - - - -
	Sept. 16	23.3 ± 0.89	22.6 ± 1.30	- - - - -	13.9 ± 0.48	- - - - -	9.1 ± 0.35	- - - - -
	Oct. 2	18.6 ± 0.87	17.8 ± 0.79*	11.1 ± 0.55	- - - - -	9.3 ± 0.59	- - - - -	7.2 ± 0.24
Katahdin	Aug. 31	31.9 ± 0.92	25.7 ± 1.32	21.1 ± 1.57	- - - - -	12.2 ± 0.35	- - - - -	- - - - -
	Sept. 16	35.8 ± 1.54	33.4 ± 1.47	- - - - -	18.0 ± 0.85	- - - - -	11.3 ± 0.62	- - - - -
	Oct. 2	32.3 ± 1.21	27.0 ± 1.29	22.4 ± 0.81*	- - - - -	16.8 ± 0.59	- - - - -	12.6 ± 0.41
Pontiac	Aug. 31	29.0 ± 1.22	21.9 ± 1.32	17.8 ± 0.85	- - - - -	9.3 ± 0.23	- - - - -	- - - - -
	Sept. 16	29.0 ± 1.20	24.6 ± 1.42	- - - - -	17.9 ± 1.65*	- - - - -	10.3 ± 0.52	- - - - -
	Oct. 2	25.5 ± 0.92	23.5 ± 1.66	17.4 ± 0.69	- - - - -	13.0 ± 0.68	- - - - -	8.6 ± 0.27
Sebago	Aug. 31	26.0 ± 1.01	18.2 ± 0.78	16.9 ± 0.58	- - - - -	8.8 ± 0.28	- - - - -	- - - - -
	Sept. 16	25.1 ± 0.85	23.7 ± 1.14	- - - - -	14.3 ± 0.65*	- - - - -	8.2 ± 0.22*	- - - - -
	Oct. 2	25.6 ± 1.39	25.7 ± 0.67	17.5 ± 1.13	- - - - -	11.4 ± 0.51	- - - - -	7.9 ± 0.31

*Note: Mean calculated from 9 tubers.

There was no significant change in the ascorbic acid content of the tubers of any variety from the time of the first sampling until maturity of the vines. As soon as the tops died, the ascorbic acid content of the tubers began to decrease whether the tubers were dug and placed in storage or left in the ground. The two early varieties (Warba and Irish Cobbler) were mature at the first harvest as indicated by the condition of the tops and the nature of the periderm of the tubers. These varieties showed a continual decrease in ascorbic acid at each succeeding harvest. The Pontiac, Katahdin, and Chippewa varieties were mature or had been killed at the second harvest, and a significant decrease in ascorbic acid content of the tubers was observed at the third harvest. The Sebago tubers had the same ascorbic acid content at each of the three harvests and the tops were still living at the third harvest.

These data indicate that the ascorbic acid content of potato tubers was not affected by the stage of maturity of the tubers as long as the tops were living. This does not necessarily mean that there is no effect of maturity on the ascorbic acid content of potato tubers. The tops of the plants had attained their maximum size at the time of the first harvest, and only one variety (Sebago) showed an appreciable increase in yield of tubers. Therefore, the range of maturity studied was not very great. In addition, the effect of the different environmental conditions prevailing at each harvest date cannot be validly separated from the effect of maturity in this type of experiment. The loss of ascorbic acid in the tubers upon death of the tops may be considered conclusive since it was observed with more than one variety on each of two harvest periods. This observation has also been reported by Smith and Gillies (5).

The problem of evaluating potato varieties as sources of ascorbic acid is illustrated by the data presented in table 1. Since the ascorbic acid content of the tubers decreased after the tops died, the ascorbic acid content of Warba and Irish Cobbler potatoes at the first harvest only is valid. If all varieties are compared at the first harvest, the stage of maturity must be ignored. A comparison made at the time of maturity necessarily ignores the possible effect of climatic differences at the various harvest dates. A comparison of the ascorbic acid content of these varieties at the time each variety was mature shows that the Warba and Katahdin tubers were high; Sebago, Pontiac, and Irish Cobbler were intermediate; and the Chippewa tubers were low in ascorbic acid. These results should be accepted with reservation since the varieties were grown in unreplicated fields and the varieties matured at different times.

Samples of these potatoes were found to decrease in ascorbic acid content throughout the period of storage (3 months) at 40° F. as is shown in figure 2. There were differences in the rate of loss of ascorbic acid, in some cases apparently associated with maturity or date of harvest. However, the nature of the data does not warrant a conclusion as to the effect of maturity of the tubers on the loss of ascorbic acid during storage. It is interesting to note that the Warba and Irish Cobbler tubers significantly increased in ascorbic acid when placed at 40°F. after the third harvest, at which time the tops had been dead for one variety and occurred with the Warba and Irish Cobbler varieties only after the third harvest. This increase was not noted with any other variety and occurred with the Warba and Irish Cobbler variety only after the third harvest. The ascorbic acid content of tubers of these two varieties was significantly higher after two weeks' storage at 40° F., but after this time, the ascorbic acid content rapidly decreased. After approximately six weeks' storage, the ascorbic acid content of these tubers was about the same as that of tubers harvested earlier and stored for the same length of time. These changes in the ascorbic acid content of the potatoes in storage could not be accounted for by changes in the per cent dry weight of the tubers. The same relationships held when the ascorbic acid was calculated on a dry weight basis.

In an attempt to evaluate potato varieties as sources of ascorbic acid, it is imperative to consider both the time of maturity and the length of time in storage. In effect, the storage period begins as soon as the tops die since the tubers are then dependent upon stored carbohydrates. When a number of varieties are harvested at the same time, the varieties maturing before the time of harvest have actually been in storage for a period of time. Therefore, this type of comparison is biased. Harvesting all varieties when the earliest-maturing variety is mature also introduces a bias because the later-maturing varieties would be immature. A comparison of the ascorbic acid content of potato varieties at the time of maturity is another alternative; such a comparison would also be biased since the various varieties would mature with different climatic conditions prevailing. It is obvious that more comprehensive experiments are needed before an extensive study of the ascorbic acid content of potato varieties can be undertaken.

SUMMARY

Six varieties of potatoes were harvested on each of three different dates during the last month of the growing season. The ascorbic acid content of the tubers did not change as the tubers matured. Upon death of the tops, the ascorbic acid content of the tubers began to

decline. The tubers continued to lose ascorbic acid in storage throughout the two-month storage period studied. A satisfactory method of comparing the ascorbic acid content of potato varieties has not been devised at the present time.

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REPORT OF THE ANNUAL MEETING OF THE POTATO ASSOCIATION OF AMERICA

ANNUAL MEETING

The annual meeting of the Potato Association of America, held at Pittsburgh, December 6, 7 and 8, 1948 was well attended despite the fact that announcements of the meeting were late in reaching the majority of the membership. A total of 94 persons registered and numerous other persons who did not register attended some of the sessions. The quality of most of the papers presented at the meeting was excellent and they will be published in subsequent issues of the Journal for the benefit of all members.

MEETING OF THE 1948 EXECUTIVE COMMITTEE

At the business meeting of the Executive Committee held Sunday evening, December 5, Vice-President Burke in the absence of President Newdick, appointed the following committees:

Auditing Committee:
H. W. Darling, *Chairman*
I. N. Hopkins
W. R. Mills

Nominating Committee:
Rinear Bonde
Frank Garrett
R. C. Hastings

President Newdick previously appointed the following to the *Potato Introduction Committee*:

G. Rieman, *Chairman*
F. J. Stevenson
Donald Reddick
Julian C. Miller
William Riedl

The Treasurer was authorized to charge a mark-up of 25 per cent above the cost of reprints for articles printed in the Journal, but no charge was to be made for mailing or handling. There being no further business the meeting was adjourned.—H. A. REILEY, *Secretary*.

Since this authorization was granted the publisher has increased

the cost of printing 6 per cent, for this reason the Treasurer has increased the price of reprints only 20 per cent above our cost.

Meeting of the Potato Association of America

At the Annual Business Meeting held Tuesday morning, December 7 Vice-President Burke again presided. The Secretary read a letter from President Newdick expressing his regret for not being able to attend. Following the reading of the minutes of the last annual meeting the Treasurer's report was given and accepted. A copy of this report appears on page 72.

The Auditing Committee examined the books and certified that they were correct.

The Editor's report was made by Mr. Campbell in the absence of Dr. Martin. This report included a breakdown of the membership of the Association by states. It was pointed out that there was a total of 2667 members of which 1700 were group members, received at special reduced rates.

The Nominating Committee presented the following panel to serve on the Executive Committee for the year 1949. President, O. D. Burke, Extension Plant Pathologist, Pennsylvania State College; Vice-President, H. A. Reiley, of the Michigan Potato Growers' Exchange, Cadillac. Three directors were also elected: I. W. Hopkins, a prominent farmer of Pittsford, New York — 1 year; J. W. Scannell, Assistant Chief, Division of Plant Protection, Ottawa, Canada—2 years; and A. J. Tolaas, in Charge of Seed Certification, Department of Agriculture, St. Paul, Minnesota — 3 years.

Since there were no nominations from the floor the Secretary was requested to cast a ballot for the entire panel and they were unanimously elected.

The following officers were appointed by the newly elected President at the meeting of the Executive Committee held on the evening of December 7. Secretary—2 years; Ora Smith, Department of Vegetable Crops, Cornell University, Ithaca, New York, Treasurer—1 year; John C. Campbell, Department of Plant Pathology, Rutgers University, New Brunswick, New Jersey and Dr. William H. Martin, Dean of the College of Agriculture, Rutgers University was reappointed as Editor of the "American Potato Journal." E. L. Newdick, former president, will continue to serve on the executive committee as provided by the By-Laws.

Dr. G. H. Rieman presented the following recommendations regarding the establishment of a National Potato Introduction Station at

Sturgeon Bay, Wisconsin. The primary purpose of this Station is to collect and maintain species of potatoes that may have desirable breeding characteristics for use by geneticists in the various states and the U.S.D.A.

The recommendations were adopted as follows:

We recommend that the North Central Potato Introduction Station at Sturgeon Bay, Wisconsin, as now established, be organized as the National Potato Introduction Station, to serve the four regions of the country and the United States Department of Agriculture as designated in the Research and Marketing Act of 1946.

That further provisions be made to study the cytogenetic and systematic relationships of the new introductions to facilitate Potato Breeding programs throughout the Nation.

It is recommended that the Potato Introduction Committee representing the four regions and the United States Department of Agriculture, be appointed by The Potato Association of America and be authorized to formulate a National Potato Introduction Project.

It is recommended that the Secretary of the Potato Association of America submit the outline of this project to the following four Regional Administrative Advisors and the Chief of the Bureau of Plant Industry, Soils and Agricultural Engineering, and that the project outline be published in the American Potato Journal.

DR. S. V. SWENSON
State College of Washington
Pullman, Washington

DR. W. V. LAMBERT
Nebraska Agricultural Experiment Station, Lincoln, Nebraska

DR. J. L. LEWIS
College Station
Texas

DR. A. J. HEINICKE
Agricultural Experiment Station,
Geneva, New York

DR. ROBERT SALTER
Plant Industry Station, Beltsville, Maryland

Prepared by the POTATO INTRODUCTION COMMITTEE FOR 1948 OF THE POTATO ASSOCIATION OF AMERICA

REINER BONDE
F. J. STEVENSON
L. C. PETERSON
G. H. RIEMAN, *Chairman*
L. W. NIELSON

No report was made by the Life Membership Committee. However, it was recommended that the names of persons to be so honored be obtained from Mr. Koehnke and that they be duly notified of this honor, and that proper citations be printed in the Journal.

Report of the Resolutions Committee, Chairman H. C. Moore: Be it resolved, that we the members of the Potato Association of America

express our appreciation for the services and untiring efforts of John Campbell and O. D. Burke in arranging the program for this excellent meeting.

Be it further resolved, that we express to Dr. William H. Martin our appreciation of his invaluable contribution to the continued success of this organization in the regular issuing and successful financing of the American Potato Journal.

Further, that we express our appreciation to those who have contributed articles and sectional notes for the American Potato Journal.

Be it resolved, that we extend our appreciation to the Hotel Fort Pitt for its co-operation in furnishing meeting rooms and other accommodations.

Be it further resolved, that we extend our thanks to the Pittsburgh Convention Bureau for the secretarial services of Mrs. Norris who has had charge of membership registration.

H. J. EVANS
H. C. MOORE, *Chairman*

Following the acceptance of these resolutions the meeting was adjourned.

Respectfully submitted,
H. A. REILEY, *Secretary*.

MEETING OF THE 1949 EXECUTIVE COMMITTEE

At the meeting of the newly elected Executive Committee held Tuesday evening, December 7, Messrs. Burke, Reiley, Campbell, Smith, Hopkins and Scannell were present. Martin, Newdick and Tolaas were absent. President Burke presided and the following items of business were transacted.

(1) *Annual Meeting in* 1949

The Executive Committee voted to hold the next annual meeting in connection with the meeting of the International Crop Improvement Association on December 7, 8, 9, 1949, in Kansas City, Missouri, at the Hotel President.

(2) *Call for Papers*

It was agreed that the Secretary should send the notice for a call for papers to Dr. Martin in time to be included in the August or September issue of the Journal.

Deadline for submitting titles to the Secretary was set for October 20. Deadline for receipt of abstracts by the Secretary was set for November 15.

The Secretary is to submit the program of the meeting to Dr. Martin as soon as it is prepared for printing.

(3) *Expenses*

It was decided that:

(a) The Secretary should receive compensation to pay for work necessary to take care of secretarial duties and purchase of supplies.

(b) The Editor should receive a compensation of $400.00 annually.

(c) The Treasurer should receive a compensation of $600.00 annually.

(d) The Treasurer should be authorized to present Christmas presents to those who have done secretarial work during the year without compensation.

(4) *Committees*:

The following committees were appointed by President Burke:

Potato Introduction Committee: Donald Reddick, F. J. Stevenson, C. O. Erlanson, W. A. Riedl, J. C. Miller—and G. H. Rieman, *Chairman*.

It is suggested that this committee handle potato introduction affairs under the Research and Marketing Act.

Certification Committee: R. C. Hastings, K. W. Lauer, C. H. Godwin, W. H. Dunlap—and H. M. Darling, *Chairman*.

Membership Committee:

Marx Koehnke, Alliance, Nebr. (Central States)
Wm. Keenan, Ottawa, Canada, (Canada)
Frank Garrett, Fairhope, Ala. (Southern States)
Wm. Camp, Bakersfield, Cal. (Pacific Coast States)
H. J. Evans, Georgetown, N. Y. (Northeastern States)
E. C. Moll, Columbus, Ohio (Ohio, Indiana, Michigan)
Donald C. Umphrey, Presque Isle, Maine (New England States)
C. G. Woodbury, Idaho (Northwestern States)

Committee on Visual Education: R. J. Haskell, Washington, D. C.; Wm. Keenan, Ottawa, Canada; Gordon Brandeis, Philadelphia, Pa.; Duties: to locate movies, slides, photographs, *etc.* which would be suitable for the use of groups interested in potato production and marketing and to bring them to the attention of the Association.

Editorial Committee: The executive committee went on record authorizing the President to appoint an Editorial Board if the Editor feels that such assistance is desired.

Local Arrangement Committee: To be appointed later.

(5) *Other Business*

The Executive Committee agreed that the Association should sponsor the 1949 issue of the Potato Yearbook on terms similar to those in force for the 1948 issue.

There being no further business the meeting was adjourned.

Respectfully submitted,
ORA SMITH, *Secretary*.

SECTIONAL NOTES

ALABAMA

There seems to be a strong feeling among the Alabama potato growers to a plant a much smaller crop than allowed by the Government to qualify for support. The high cost of seed $4.35 to $4.50 per bag, the high cost of labor and fertilizer, and the effect of the reduction of parity this January seem to be the main reasons. Our farmers seem to realize that by planting less potatoes and using the best land, seed, and cultural practices that the net profit will be about the same as a large crop not so well handled. We probably will have a 30 per cent reduction in acres planted this year, there will most likely not be a 30 per cent reduction in production. There is always a probability that frost or blight could enter the picture to a very important extent.

Seed is arriving in an increasing amount and so far it seems that our dealers have purchased the best seed available. Some of the cars are showing frost in transit but this is a minor matter. Sixty five per cent of our crop will be Triumphs and the balance Sebago. Nebraska and North Dakota will furnish the bulk of Triumph seed with some from Minnesota. Wisconsin will furnish the bulk of the Sebago seed with P.E.I. selling quite a few cars. Maine will probably have a few cars in here also.

With normal weather conditions our growers will start planting in late January and will complete the bulk of the planting in approximately two weeks.

Our present plans call for some 225 samples of seed sources to be planted at the Gulf Coast Substation for the States of Wisconsin, Minnesota, North Dakota, Nebraska, and Wyoming. There will be about 40,000 tubers in the index part of our program.—FRANK E. GARRETT.

NEBRASKA

The report on potatoes from Nebraska may or may not be published, since mail from this territory frequently has wound up in a snow drift in the last six or eight weeks. Mother Nature has been on a rampage since some time in November, so long ago, we fail to remember just when it started.

We thought weather conditions were rough in the early part of the winter, but on January 2nd, a blizzard hit this territory that is the equal to any the old timers can remember. From here on we shall talk about the blizzard of January '49. As a result of a three-day snow fall with high winds and sub-zero temperatures, we had no trains moving in the state for a period of eight days. That meant that all transportation was at a standstill during that period. Following this several of the branch line railroads on which major stocks of potatoes are located have had service only one or two days during the past thirty days. That short period, of course, meant no movement of potatoes, only critical supplies of food and fuel.

In view of the fact that the Certified seed shipments to the Gulf Coast States are usually at their peak during this period, it can be readily seen what a mess the potato business faces as of this moment.

The movement of seed potatoes is hoplessly behind schedule, and prospects of improvement are very slim indeed. Many shippers who have been very patient to date have started cancelling their orders because it will soon be too late for planting in the southland. To complicate matters further, there is a critical car shortage, because the railroads are unable to move in equipment.

The situation, of course, has affected many agricultural products, other than potatoes. In this general area, livestock is very critically affected. All local and state resources for opening roads have been mobilized, and the Federal Government is moving in the Fifth Army from Colorado and Indiana. They are moving in bulldozers, weasels, and all kinds of winter equipment for opening roads to save what livestock has survived the past thirty days of strenuous weather. High losses have already been experienced, and more are expected. Many farmers, not over 10 to 20 miles from town, have been supplied with food and fuel by airplane, and hay is being dropped to isolated cattle herds from C-47 transports.

This isn't much about the potato business, but it gives an inkling of what one territory in the country has been suffering for the past thirty to sixty days. Prospects for next year are very confused at this moment. There is a reduction proposed, but if we cannot ship our seed

potatoes south we may have an increase in acreage instead. Some of our seed potatoes are too small to be sold as table stock, and consequently will have to be salvaged in this manner. What started out to be a fairly good quality and about average yield may turn out to be a very disastrous crop before the situation clears.—MARX KOEHNKE

NEW YORK

Much interest is being manifest among potato growers regarding the 26 per cent cut reputed to be the figure for New York in the recent government allotment program announcement. There is not too much resentment about the cut but rather the course of action seems to be one of planning for more harvest production by utilization of better soils, more and better seed and approved cultural practices.

The outlook for Marketing Agreements appears better as time goes on, not only as a means of improving quality that goes to market but as a means of enforcing planting regulations. Marketing Agreements will receive considerable attention at the Annual Meeting of the Empire State Potato Club being held in Utica at Hotel Hamilton, January 5-6-7.

Favorable comment on the whole, is occasioned by the better enforcement by the Department of Agriculture and Markets of the Branding Law. Quite a few violations have occurred, potatoes requiring many potatoes to be regarded. This is having a good effect on everyone who markets.

The movement of certified seed potatoes is slow because of the uncertainty of individual farm allotments, the influx of Canadian Certified seed which came in with tags under the seed quota to table stock distributors who were supposed to remove tags before reselling, and the unsettled conditions as a whole. In the meantime, a lot of good certified seed is going to market and there will not be a surplus by spring.—H. J. EVANS

OREGON

A marketing agreement is in affect here this year for the first time. This covers the counties of Deschutes, Crook and Klamath in Oregon, and Modoc and Siskiyou, in California and involves around 25,000 acres of potatoes, mostly Russets. The cull regulation of course, is in effect, as well as a two inch minimum. U. S. Number 2's, 1B's and fringe 1's from 1⅞ to 2 inches in diameter are being diverted under the support program for livestock feeding. It has also been necessary at times to divert higher grades to livestock feeding. Growers seem to be satisfied with the present marketing agreement set up.

Acreage reduction for 1949 perhaps will not affect the Klamath area very much as growers reduced voluntarily following government demands for increased production of potatoes during the war. From an all time high of over 28,000 acres during the peak war years, the acreage has been reduced to less than 16,000 acres in 1948. It is believed that the 1949 acreage will be about the same. The practice of reducing acreage and planting only those lands in shape for good potato production is improving per acre yield and quality of the Klamath potato.— C. A. HENDERSON

SOUTH CAROLINA

Local growers are naturally disappointed in the new parity on potatoes. This, in addition to a poor general outlook and insufficient working capital has lowered the anticipated acreage to a point where practically all growers are being allowed to plant all the potatoes they desire. Not a single complaint on acreage reduction has been registered.

The huge losses because of seed rotting from excessive rains last year left many growers in poor financial condition for paying the high production costs of the 1949 crop.

It is a bit early to predict variety percentages but the old standard Cobbler is being replaced by Katahdin and Sebago. Incidentally seed for the entire crop of these white varieties is coming from Prince Edward Island because of about $1.00 per bag price differential under Maine. Seed for the small percentage of the acreage planted in Red Bliss and Pontiac is coming from the mid-west as usual. Our seed inspectors report that the seed is apparently in excellent condition. The weather conditions for land preparation are ideal. We expect to be planting by the end of this week.—W. C. BARNES

WASHINGTON

The Washington seed potato test plots are located at Camp Pendleton, California, again this year. The plots were planted on the 1st and 2nd of November. They should be ready for a disease reading the third or fourth week in January, providing the weather is not too cold. One hundred and fifty samples submitted by seventy-two growers were used for the test plots.

Seventy samples are being tested for disease in a greenhouse at Mt. Vernon, Washington. The majority of these samples are duplicates of those being tested in California in order to make comparisons of the results.

There were 2,063.5 acres of potatoes entered for certification this year with 1,727.5 acres certified. This consisted of 1,221 acres of White Rose; 389.2 of Netted Gems; 53 of Cal Rose; and the balance were Bliss Triumph, Beauty of Hebron, Burbank, Early Hose, Gold Coin, Irish Cobblers, Katahdin and Sebago. The estimate of the production for all varieties is 14,868.5 tons, or 561,722.4 bushels.

Harold S. Schaad, who has been in charge of potato certification in this state for several years left the Seed Division December 15th. He is now Potato Specialist for Balcom and Moe at Grandview, Washington.—RICHARD E. CRIPPEN

CANADA

The final estimated production of certified seed in Canada is placed at 12,847,000 bushels. This is 1,100,000 bushels more than produced in 1947 and is the highest production on record. Of this total, 5,396,700 bushels are Katahdin. This is an increase of approximately 2,000,000 bushels more than produced in 1947. There were 2,673,500 bushels of Green Mountain and 2,117,000 of Irish Cobbler produced in 1948. This shows a reduction of approximately 1,000,000 bushels in the Green Mountain variety and about 200,000 in the Irish Cobbler variety. Most of the Katahdin are produced in New Brunswick whereas Prince Edward Island produces the bulk of the Green Mountains and Irish Cobblers.

Pontiac variety appears for the first time in our list as it was not licensed for sale in Canada until 1948. There were approximately 152,000 bushels of this variety produced in 1948. Most of this stock was in New Brunswick. The yields of all varieties were quite good and most of the harvesting was done under ideal conditions.

Under a recent trade agreement between Canada and the United States, seed potatoes moved to the United States under a permit only. These permits are issued in accordance with the dates of planting, that is, that potatoes to the South are permitted to go forward now whereas potatoes to the Northern States, such as New Jersey, are not permitted entry until January 15; Maine, February 1; New York, Long Island, February 1; and New York (Up State) March 1.—J. W. SCANNELL

STATEMENT FOR THE YEAR ENDING NOVEMBER 30, 1948

Receipts:		
Balance on hand, December 15, 1947	$2,718.61	
Annual Dues	3,298.47	
Sale of Advertising	3,170.93	
Sale of Reprints	322.00	
Miscellaneous	39.98	
Total Receipts		$9,549.99
Disbursements:		
Printing of Journal (11 issues)	$4,044.01	
Printing of Reprints	323.25	
Mailing and Supplies	665.40	
Editorial Work	400.00	
Secretarial Work	650.00	
Indexing American Journal	300.00	
Miscellaneous	336.35	
Total Disbursements		$6,719.01
Balance on Hand November 30, 1948		$2,830.98

Accounts Receivable:		
Advertising for Sept., October and November	Approx.	$385.00
Reprints		129.50
Accounts Payable:		
Printing of October and November issues	Approx.	$800.00

John C. Campbell, *Treasurer.*

BOOK NOTES

The Potato. W. G. Burton, Cambridge, England: Chapman and Hall, London, 1948. Pp. 319. (Illustrated) 25/ Net.

After an excellent chapter on the history of the potato, the author discusses the various factors influencing dry matter, including the effect of climate, length of growing season, soil type, manuring, diseases and pests, and the variety and kind of seed. Additional chapters discuss the distribution and composition of the dry matter in the potato tuber, the nutritive value, cooking quality and storage. Appendices list the uses of potatoes other than for human food consumption and specific gravity as a guide to the content of dry matter and of starch in potato tubers. Each chapter is followed by a number of references.

While "The Potato" has largely to do with the crop as grown in England, all interested in the production of this important crop could read it with very great interest and profit. The author is to be congratulated on his attempt to summarize our knowledge of the potato as a source of food, more particularly from the viewpoint of a plant physiologist. Producer and research worker alike will benefit from Mr. Burton's contribution.

CORRECTION

In the January, 1949 issue, in the article entitled "Further Studies on the Influence of Sprout-inhibiting and Sprout-inducing Treatments on the Growth and Yields of Potatoes" the figures in column 2, table 3, on page 10, should head as follows:

10.9
0.4
0.2
0.6
0.3

American Potato Journal

PUBLISHED BY

THE POTATO ASSOCIATION OF AMERICA

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EFFECT OF TYPES OF CONTAINER, STORAGE AND VARIETY ON SHRINKAGE OF STORED POTATOES[1]

E. V. HARDENBURG

Cornell University, Ithaca N. Y.

The trend in retail marketing of potatoes recently has been an increase in the use of consumer packages. Approximately one-half of the potatoes handled by large chain stores are now sold in this form. Although most of these consumer packages consist of paper, such other forms as saxolin, cotton and burlap are also used. The effect of type of container on light injury and loss of weight in storage has had comparatively little study. In cases where packaged potatoes are held several weeks under warm store or warehouse conditions, weight loss due to sprouting or moisture loss may be important. Alban and Tussing (1) stored Katahdin potatoes in paper and in net bags in cold storage (35 to 45° F) and at room temperature and determined the comparative weight losses after one, four, eight, and twelve weeks. For these storage periods, the losses at room temperature were 1.2, 3.2, 6.4 and

[1]Published as paper No. 313, Department of Vegetable Crops, Cornell University, Ithaca, N. Y.

[2]Containers used in this experiment were furnished by Chase Bag Co., Buffalo, N. Y.

11.0 per cent, respectively. Losses at room temperature were two to three times higher than those subjected to cold storage. These losses were slightly less for paper bags than for net bags, the difference being 1.3 per cent in cold storage, 2.6 per cent at room temperature.

Objectives and Plan of Experiment

Although the most common type of retail store package is the two-walled, wet strength paper bag, various types of net bags, cotton and burlap are also used. The principal object of this preliminary study was to measure the effect of type of container on both moisture loss and weight of sprouts of potatoes stored under various storage environments. Two varieties packed and stored in six types of containers were held in three distinct types of storage over a period of 129 days or from the 4th of November to the 12th of March. The varieties were Sebago and Houma, the former being notably a poor keeper with prominent tuber lenticels; and the latter a good keeper with inconspicuous lenticels. Five types of package containers and the half-bushel slatted crate were used to test their influence on weight loss in storage. The three types of storage consisted of a refrigerated or controlled temperature storage, a house cellar of low relative humidity, and an insulated bank storage of fairly high relative humidity. The temperature and humidity condi-

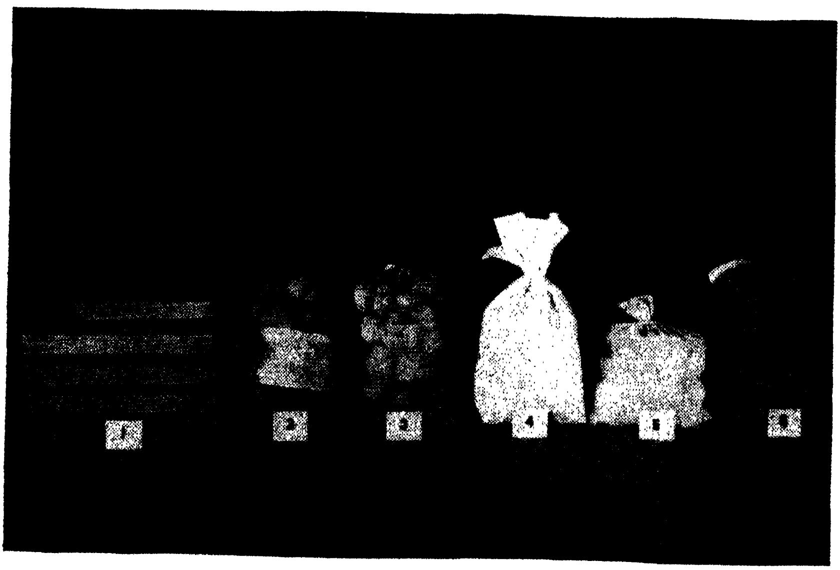

Fig. 1. Containers used in Potato Storage Experiment. Left to right: 1. Crate. 2. Saxolin. 3. Chasenet. 4. Paper. 5. Cotton. 6. Burlap.

tions of each of the three types of storage are indicated in table 2. In setting up the experiment, 12 pounds net weight of potatoes were placed in each container, the bags being tightly tied and so placed in storage that there was free air space around each sample. Although temperature and humidity readings were made at weekly intervals, no sample weighings to determine periodic weight losses were made until the experiment was terminated. At the end of the experiment, the samples were first weighed to determine moisture loss, after which they were desprouted and the sprouts, if any, weighed to determine weight loss due to sprouting. The containers listed in table 1 are illustrated in figure 1.

Results

The effect of storage container on shrinkage due to moisture loss and to sprouting is indicated in table 1. These data represent the average for both varieties and three storages. Although the average moisture loss was least for the burlap container, this difference is not significant. Contrary to the results reported by Alban and Tussing (1946), the shrinkage loss from the paper bag was not less than that for the net bags either in terms of moisture loss or sprouting. Actually, there was no significant difference in weight loss in terms of either moisture or sprouting due to type of container.

TABLE 1.—*Relation of storage container to shrinkage (Average of 2 varieties in 3 storages)*

Container	Percentage Loss in Weight		
	Moisture	Sprouting	Total
1. Crate	4.68	1.04	5.72
2. Saxolin	4.43	1.39	5.82
3. Chasenet	4.16	1.91	6.07
4. Paper	4.34	1.39	5.73
5. Cotton	4.34	1.13	5.47
6. Burlap	2.69	1.56	4.25
Average	4.11	1.40	5.51

That potato sprout development is directly related to storage temperature is well known. It is also well known that 40° F. is the threshold temperature for sprout development in storage. These facts are

substantiated by the data on loss due to sprouting in each of the three storages as shown in table 2. Shrinkage due to sprouting varied directly with temperature, there being no sprout growth in either variety at the 40° F. level. Apparently temperature was more influential on sprout growth than was humidity. Also, somewhat contrary to prevalent opinion, Sebago showed no significantly greater tendency to sprout than did Houma under the conditions of this experiment.

Shrinkage caused by moisture loss averaged more than double in Sebago that of Houma and was significantly highest in the house cellar or low humidity storage. The greater moisture loss from Sebago may well be due to a higher transpiration rate associated with the large prominent tuber lenticels characteristic of this variety. There is also in these data an indication that humidity is more influential on shrinkage caused by moisture loss or transpiration than is temperature.

TABLE 2.—*Relation of type of storage and variety of weight shrinkage. (Average of 6 types of containers)*

Storage	Variety	Moisture Loss Per cent	Sprout Weight Loss Per cent	Total Loss Per cent
Refrigerated	Sebago	4.34	1.13	5.47
52° F.	Houma	2.60	1.39	3.99
75 per cent humidity	Total	6.94	2.52	9.46
House Cellar	Sebago	7.90	0.28	8.18
48° F.	Houma	2.77	0.00	2.77
35 per cent humidity	Total	10.67	0.28	10.95
Bank Storage	Sebago	5.12	0.00	5.12
40° F.	Houma	1.91	0.00	1.91
65 per cent humidity	Total	7.03	0.00	7.03
Average	Sebago	5.79	0.47	6.26
	Houma	2.43	0.46	2.89

CONCLUSIONS

Three factors were studied in this experiment to test their relation to shrinkage of potatoes in storage. These factors are storage container, variety and type of storage. Six types of containers were used; two varieties to wit, Sebago and Houma; and three storages, namely a re-

frigerated storage temperature 52^3 F. and 75 per cent relative humidity), a house cellar (temperature 48° F. and 35 per cent relative humidity) and and insulated bank storage (40° F. and 65 per cent relative humidity). The test involved the use of 36 twelve-pound lots of potatoes. Since no replicates were used, the data are not analyzed for significance. However, all data presented are the result of averaging a number of samples and consistency of data is considered in the conclusions drawn.

The following conclusions seem to be justified from the data presented in tables 1 and 2. (1) At the end of 4 months (129 days) of storage of two varieties in three storages, the weight shrinkage was not significantly different for 5 types of closed containers and the open slatted potato crate. (2) Of a total shrinkage of 5.51 per cent (table 1) for 4 months of storage, 75 per cent was caused by moisture loss, 25 per cent to sprouting; (3) Shrinkage due to sprouting was primarily a function of temperature whereas shrinkage due to transpiration was primarily a function of relative humidity; (4) Contrary to prevalent opinion, the Sebago variety showed no greater tendency to develop storage sprouts than Houma: (5) the Sebago variety showed an approximately 60 per cent greater weight loss from transpiration than did the variety Houma. This difference may be due to the larger, more prominent lenticels characteristic of Sebago.

Literature Cited

1. Alban, E. K. and E. B. Tussing. 1946. Weight loss of potatoes stored in various containers. Amer. Potato Jour. 23: 302-304.

EFFECT OF DRIFT OF 2, 4-D SPRAY ON IRISH POTATOES

C. E. ROSENQUIST

University of Nebraska, Lincoln, Nebr.

A new problem has become apparent in the small grain areas of South Dakota and Nebraska where potatoes are common in rotation. While inspecting potatoes grown for certification in these areas in the summer of 1948, the writer noticed several fields of potatoes showing slight to severe injury from 2, 4-D that had been applied to control weeds in nearby fields of small grains and flax. The most common rate of application was ½ lb. of 2, 4-D acid per acre, but continued drifting during the spraying operations may undoubtedly increase that rate considerably.

Thompson and Shuel[5] using 1.2 pounds per A. of free acid in the 2, 4-D spray upon Katahdins at four weeks from maturity found no detrimental effects whereas upon Cobblers at two weeks from maturity, severe chlorosis was observed with no indication of recovery. Bradley and Ellis[3] using ½, ¼, ¾ and 1 lb. acid per acre, respectively upon the variety Katahdin, found little effect upon the vines except at the 1-lb. rate and this was not very severe. Ennis *et. al.*[2] using 1g. 2, 4-D acid per sq. yd. on Irish potatoes in the early bud stage found that the yield was reduced to 27 per cent compared with that of the untreated check. No results of experiments with 2, 4-D applied to the varieties Triumph and Warba were found in the literature.

Bliss Triumph and Warba Irish Potato plants appeared rather susceptible to injury by 2, 4-D. Affected leaflets darkened slightly and were smaller and more sharply pointed than were healthy leaflets. However, the most striking characteristic was the abundance of small raised areas on the leaflets. The immature leaflets were the most susceptible, and they frequently ceased growing following contact with the spray material. If the plants were quite young (below eight inches in height) they often recovered and put out new leaves. More nearly mature plants receiving the spray ceased growth almost entirely.

A 16-acre field of Triumph potatoes lying south and adjacent to a recently sprayed oat field afforded a good example of injury to plants sprayed when in the early blossom stage. When observed a week after the spray drift, 2, 4-D injury was pronounced. Leaflets were small, dark, and "knobby"; the stems were a dark red to green-red in color.

[1]Associate Professor of Botany.

The shape of the field was almost square. The 2, 4-D spray had drifted about 200 yards across the field in such abundance that injury at the side most distant from the sprayed oat field was almost as severe as that adjacent to it.

This field of potatoes was planted on the 25th of April and harvested on the 8th and 9th of September. Another 16-acre field, about one mile away was planted from the same lot of seed on the 28th of April and harvested from the 11th-13th of September. The "injured" field was the more fertile of the two, according to the grower. The number of tubers on the plants was approximately the same in each field, but the tubers in the injured field were considerably smaller. The vines in the injured field did not die earlier than those in the "uninjured" field, but there was no apparent growth after the spray drift period. The yields of potatoes were 128 bushels per acre from the injured field and 158 from the uninjured. This represents a decrease in yield of approximately 20 per cent, but, because of the smaller tubers from the injured field, the actual decrease in No. 1 potatoes was undoubtedly greater.

Other fields of potatoes including Warbas affected by the drift of 2, 4-D were observed, but though damage was obvious it was not so severe as that described above. It is apparent that growers planning to use 2, 4-D for weed control must take into consideration the possibility of drift of the material to fields of susceptible plants.

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A REPORT ON SUN-DRYING OF POTATOES FOR STOCK FEED IN NEBRASKA*

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The Nebraska Potato Development Division Advisory committee, at a meeting in Gibbon on the 3rd of August 1948, voted to sponsor a project for natural, or sun-drying, of surplus and cull potatoes from the 1948 central Nebraska crop. There seemed ample justification for expenditure of money for this type of work, as a guide to determine the practicability of large-scale sun-drying, and the value of such a product as feed for livestock. Both artificially and naturally dehydrated potatoes have proved comparable to corn in feeding tests at various Experiment Stations, including the Scottsbluff Farm, (1) but no extensive project of this type had as yet been conducted in the state.

In July, the Animal Husbandry department of the Nebraska College of Agriculture, under the supervision of Dr. Marvel Baker, obtained a truckload of potatoes through the Production and Marketing Administration, for sun-drying experiments. This preliminary test showed that when tubers were cut into slices from one-eighth to one-quarter inch thick and spread on a cement strip in layers up to three inches deep they dried to ten or eleven per cent moisture content within four days. This moisture content is about equal to that of corn, and an analysis of the protein, nitrogen-free extract, fat, ash, and fiber percentage showed a similar correlation. (See table 1.)

Following the test at Lincoln, an agreement was signed, jointly, by the College of Agriculture, the Production and Marketing Administration, and the Potato Development Division to obtain up to five carloads (360 sacks per car) of surplus potatoes, U. S. No. 2, or U. S. No. 1 Size B grades from the central Nebraska crop. No charge was to be made for the potatoes, washed, graded, and in new sacks, but transportation was to be paid the shipper. This cost was ultimately taken care of by returning the sacks to the shipper from whom the potatoes were obtained. The Peterson Potato Company and the Herbert Campbell Company supplied all potatoes used in the project, trucking them to the drying site from Gibbon, Shelton, and Wood River Nebraska.

[1]Chief, Division of Potato Development.

Through the efforts of the Chamber of Commerce and city officials of Grand Island, Nebraska, 140,000 square feet of oil-mat area at the Grand Island airport was obtained. The problem of securing a machine which would slice the potatoes in a reasonable length of time, without crushing, was solved by the offer of a David Bradley ensilage cutter from the local Sears-Roebuck farm store. The fans were removed from the knife wheel, leaving only the knives on the wheel. The bottom half of the wheel housing was removed, and covered with wire netting, in order that the sliced potatoes would fall instead of being blown upwards, as would have been the case if the fans were attached to the knife wheel.

The ensilage cutter was mounted on a loading dock near the drying strip, with the wheel housing extending over the edge of the platform. Manure spreaders were backed under the dock, and sliced potatoes fell into the machines, to be placed on the oil-mat area for drying. Tractor power, at idling speed, proved most satisfactory for operating the ensilage cutter, with a knife speed of 175 RPM providing more uniform slices one-quarter inch thick. The speed at which the potatoes were fed into the machine also governed the uniformity of slicing. Best results were obtained at the above-mentioned RPM with potatoes going through the machine at the rate of 65 sacks per hour. Faster operations resulted in poor uniformity, many slices being too thick for proper drying.

Manure spreaders proved ideal for scattering the sliced potatoes at an even depth on the drying strip, in this case about one inch. At the beginning of the spread it was necessary to level the pile by hand raking, but the labor involved was negligible. The depth of spread was dependent on the speed at which the spreader operated, slow speeds proving less satisfactory than a moderate, or faster rate. All tractor and spreader equipment, as well as labor, was supplied by Elmer Petersen and Richard Youst, of the Grand Island Potato Company, and by the City of Grand Island.

TABLE I.—*Chemical analyses of sun-dried potatoes and corn*

Product	Moisture Per cent	Protein Per cent	Fat Per cent	Ash Per cent	Crude Fiber Per cent	Nitrogen-Free Extract Per cent
Dried Potatoes	9.0	8.7	0.7	4.3	2.0	75.2
Corn	10.8	10.1	3.9	2.3	2.0	70.9

The first sliced potatoes were placed on the drying area on the 18th of August, and stirred once a day with a hayrake, which was sufficient to permit air and light to reach all portions of the piles. All potatoes that were spread the first day were dry by the afternoon of the 21st, whereas later spreads made on the 19th and 20th of August were dry by the evening of the 23rd. Weather conditions during the entire period were ideal, with Grand Island reporting a temperature range of 70 to 102 degrees, and no precipitation.

On the 24th of August the dried potatoes were swept into windrows with a motor-driven street sweeper, supplied by Peter Kewit and Sons, of Grand Island. This method of piling the feed proved very satisfactory, but some foreign material accumulated with the potatoes. A cleaner area, such as a cement strip, would be more desirable in future operations of this type. However, the motor-driven sweeper was very economical, taking only two hours to pile the entire amount of feed on the area into five windrows. The potatoes were then loaded into a truck by means of scoop shovels and hand labor, this operation taking only three-and-one-half hours and representing most of the non-mechanized labor involved in the drying process.

A total of one thousand sacks of potatoes was sliced and spread on the drying area, which, from previous results, should have yielded between five and ten tons of stock feed. The cost of the project averaged about seventy-five dollars per carload of 360 sacks, and the resulting feed was delivered to the Animal Husbandry Department of the College of Agriculture, in a truck furnished by them, for experimental feeding to their herd. Results of the feeding value will be forthcoming soon.

A breakdown of the cost involved shows that, excluding the price of the potatoes, this feed was produced for $4.50 per ton of fresh potatoes. The Production and Marketing Administration paid fifty per cent of the U. S. No. 1 support price, or $1.27½, for these potatoes, and at that figure the feed could be produced commercially for about $30.00 a ton, if handled in a similar manner, or less, if cull and pickout potatoes were fed on the farm where grown.

Nebraska, being a large stock-producing, as well as potato-growing state, is in a more favorable position to utilize the cull and surplus potatoes from its crop in this manner than most areas. Many large potato-producing sections raise little livestocks, or *vice versa,* and potato feed would have to be imported, with transportation charges increasing the cost. The opportunity to produce high-quality stock feed, at low cost, exists in the state at present. This should become a

part of the regular farm program, annually, with all cull and surplus potatoes fed to livestock on the farm where the potatoes are produced.

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FIVE YEARS OF BACTERIAL RING ROT

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Each year since 1943 an annual survey has been made of table stock potatoes on Ontario farms by the Provincial Department of Agriculture as a part of their program for the control of bacterial ring rot. In every case where the presence of ring rot was suspected, specimens were submitted to either the Ottawa or the St. Catharines laboratory of the Division of Botany and Plant Pathology, Dominion Department of Agriculture, for confirmation by microscopic examination.

With the fifth of these surveys now completed, it seems to be an opportune time to take stock of the situation and assess the value of these annual surveys. We have in our files a record of every case of bacterial ring rot reported from 1943 to 1947. Through an analysis of these data we have derived some interesting information concerning the prevalence, persistence and spread of bacterial ring rot in this province.

In the five-year period, bacterial ring rot was reported on a total of 1,630 farms. On 1,310 of these farms (81 per cent) it was reported in one year only. Ring rot was found on 268 farms twice, on 52 farms three times, and on 3 farms four times in the five years. Thus a total of 320 farms had ring rot more than once in this period.

The question is often asked: "Is bacterial ring rot increasing in this province?" In order to answer this question, let us take the reports year by year, as summarized in table 1.

*Contribution No. 931 from the Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa Canada.

TABLE 1.—*Number of farms and approximate acreage infested with bacterial ring rot as revealed by annual surveys 1943 to 1947 inclusive.*

Year of Survey	Individual Farms			Approximate Total Acreage		
	Number Inspected	Number Infested	Percentage Infested	Number of Acreage Inspected	No. of Acres Infested	Percentage Infested
1943	902	157	17	10,000	1,200	12
1944	3,000	463	15	30,000	2,800	9
1945	3,300	281	9	31,000	1,200	4
1946.	3,200	673	21	31,000	3,640	12
1947	3,100	351	11	30,000	1,900	6

In 1943, 902 farms were inspected and 157 (17 per cent) were found to be infested. On an acreage basis this represented approximately 1,200 acres (12 per cent) of 10,000 acres inspected.

In 1944, approximately 3,000 farms were inspected, and 463 (15 per cent) were found to be infested. This represented approximately 2,800 acres (9 per cent) of 30,000 acres inspected.

In 1945, approximately 3,300 farms were inspected, and 281 (9 per cent) were infested. This represented approximately 1,200 acres (4 per cent) of 31,000 acres inspected.

In 1946, 3,200 farms were inspected and 673 (21 per cent) were found to be infested. This represented approximately 3,640 acres (12 per cent) of 31,000 acres inspected.

In 1947, 3,100 farms were inspected and 351 (11 per cent) found to be infested. This represented approximately 1,900 acres, (6 per cent) of 30,000 acres inspected.

Although the number of positive cases reported per year has increased since the first year of the survey, it will be seen from these data that this does not represent an increase in the prevalence of the disease but is the result of more comprehensive surveys covering larger numbers of farms over a wider territory. With the exception of the 1946 season, the percentage of infested farms has decreased since the first survey. The data given on an acreage basis reflect the same trend.

Not only has there been a reduction in the number of infested farms, but there has been a corresponding reduction in the amount of the crops infected on these farms. In the early years of the survey, inspectors reported finding as high as 60 per cent of the plants in some fields infected with ring rot. In 1947 they found low rates of infection — often only a trace — on the majority of the fields inspected. This meant a big increase in the yield of marketable tubers suitable for table stock purposes from farms where ring rot was present.

Another question that can be answered from our experience of the past five years is this: "How effectively is bacterial ring rot being controlled?" As with practically all of our plant diseases, control of ring rot depends on prevention rather than cure. The control measures that we have advocated are as follows:

1. If even a trace of ring rot appears on the farm, dispose of *all* potatoes grown there that season.
2. Disinfect storages, cellars, bins, barrels, etc., with bluestone, formalin or lysol.

3. Disinfect tools, planters, diggers, graders, etc. with formalin or lysol. If such equipment has been used on another farm, disinfect it before using it on your own.
4. Disinfect bags, gloves, etc. with formalin.
5. Buy *certified* seed potatoes for planting next season, *Never plant table stock potatoes.*

If these precautions are followed faithfully, ring rot can be eliminated from any farm in one season. It is fortunate that the causal organism does not live over winter in the soil; however, it is wise to rotate crops to eliminate volunteer plants growing from tubers left in the ground.

Let us look over the records again to see how effectively the growers have checked ring rot after having it on their farms. For this purpose we have followed each case through to the third year from the original infection. The reason for this is that ring rot may not be found the first year after a clean-up, yet re-appear the following year. This suggests that the clean-up was not 100 per cent effective and that a trace of disease, though not detected, was carried through the next season and multiplied, so that it was apparent again the third year. If more than one year elapses between the appearances of ring rot, we assume that the crop has become re-infected from some other source.

Whereas of the 157 farms that had ring rot in 1943, 134 were apparently free in 1944, 23 (15 per cent) remained infested. In 1945, 3 farms were still infested while 9 that were apparently free the previous year had it again. Thus a total of 12 farms (8 per cent) had ring rot the third year.

Whereas of 463 farms that had ring rot in 1944, 425 were apparently free in 1945, 38 (8 per cent) had it again. In 1946, 13 farms were still infested while 65 that were apparently free the previous year showed the presence again. Thus a total of 78 farms (17 per cent) had ring rot the third year.

Of 281 farms that were infested with ring rot in 1945, 220 were apparently free in 1946, while 61 (22 per cent) had it again. In 1947, 12 farms were still infested while 17 that were apparently free the previous year had it again. Thus a total of 29 farms (10 per cent) had ring rot the third year.

Of 673 farms that had ring rot in 1946, 607 were apparently free in 1947 while 66 farms (10 per cent) had it again.

In 1947 ring rot was found on 351 farms. Of these 265 had it for the first time in the five-year period.

These records indicate that, again with the exception of the 1946 season, an increasing number of growers have been successful in eliminating ring rot from their farms in one year. There is no reason why the other growers could not do the same. The number of farms infested with ring rot the second year is still too high; the number having it beyond the second year is inexcusable.

In all respects 1946 was a peak year, and the situation revealed by the survey was discouraging. The highest number and percentage of infested farms were reported in 1946, and these included the highest proportions of both first and second year repeat cases. However, we must bear in mind that the disease that appears in the crop of any given season comes almost entirely from infected seed produced the previous season. It is not evident what factors contributed to this build-up of infection in 1946.

Finally, let us consider the question: "Is the ring rot survey worth-while?" The purpose of the survey is two-fold: to provide information on the prevalence and distribution of ring rot year by year, and to bring it to the attention of the growers wherever it is found, so that they can take steps to control it. As indicated in the foregoing discussion, losses due to ring rot have been materially reduced because fewer farms were infested and through lower rates of infection. The cost of the survey is negligible in comparison with the direct benefits to the producers.

In support of the annual surveys some interesting cases may be cited. For example in Carleton County ring rot was found on 9 farms in the 1944 survey. Due to unavoidable circumstances, no survey of this county was conducted in 1945. When the next survey was conducted, in 1946, ring rot was found on 44 farms and high rates of infection were reported in many cases. In 1947 ring rot was found on only 6 farms in this county (although the conditions for inspection were admittedly not good.)

Outstanding success in eradicating ring rot has been revealed by the survey in certain districts. For example, ring rot was found on 22 farms in Wentworth County in 1946. An intensive survey in 1947 failed to reveal a single positive case in that county. Other districts have equally good records.

To sum up our observations we may say that, on the whole, the results of the surveys have been encouraging, and that the outlook for ring rot control in Ontario is bright. Nevertheless, we must not relax our vigilance — every potato grower must be on his guard against this destructive disease.

ABSTRACTS OF PAPERS PRESENTED AT THE ANNUAL MEETING OF THE POTATO ASSOCIATION OF AMERICA, PITTSBURGH, PA., DECEMBER 6, 7, AND 8, 1948

Spraying potatoes for the control of diseases and insects in Maine. REINER BONDE. The neutral copper and organic spray fungicides, when combined with DDT have for the past four years given higher yields of potatoes than has Bordeaux with DDT. The latter in contrast gave the best control of late blight. The greater yields received with some zinc-containing fungicides in comparison with copper fungicides did not. appear to be due to zinc stimulation but to being less injurious to the potato foliage. DDT when combined with any fungicide increased both the fungicidal and insecticidal value of the spray mixture.

The percentage of metallic copper in a dust fungicide affected the yield rate and the control of late blight less than did the time of application and the coverage of the foliage. Talc combination dusts containing only four and five per cent metallic copper gave good control of the diseases when properly applied. Good control of insects and diseases and high yields were secured with Copper-Lime-DDT dust mixtures provided they were used soon after they had been prepared.

The loss to the potato crop from injury caused by the wheels of the sprayer or duster was from 23 to 40 bushels per acre or from 5.1 to 8.6 per cent of the crop, depending on the length of the boom.

"Sprout inhibition of non-dormant Chippewa potatoes." R. H. BRADELY and LESLIE L. DEAN. Satisfactory sprout inhibition on non-dormant Indiana-grown Chippewa potatoes was achieved by the use of certain growth-regulating materials. Compounds used were the sodium salt of beta-naphthoxyacetic acid, sodium salt of naphthaleneacetic acid, naphthaleneacetic acid, methyl ester of beta-napthoxyacetic acid, and methyl ester of alpha-naphthaleneacetic acid. The experiment was designed to exhibit the effects of three concentrations, 1, 3 and 9 grams of growth regulator per bushel of potatoes, as well as three methods of application,—dusted, dipped and dried at 70° F., and dipped and dried at 135° F. The data indicate that greater concentrations of growth regulators are required to inhibit sprouting after dormancy is broken.

Some effects of restricting the oxygen supplied to potato roots. JOHN BUSHNELL. Plants grown in gravel culture in jars with the tops sealed off with soft paraffine were supplied with air diluted with nitrogen to reduce the oxygen in the mixture to 15, 10 and 5 per cent. The roots were able to use oxygen at the lowest concentration. The reduction in oxygen reduced the growth of the main stem, the leaflets and the tubers,

but stimulated the growth of branches, while having very little effect on the roots. It also increased the proportion of dry matter in the tops as a whole. The volume of oxygen consumed by roots of young plants was approximately three times the volume of the water absorbed.

Potato vine killing in Prince Edward Island. L. C. CALLBECK. Killing potato vines prior to harvesting the crop is a practice that has been widely developed and adopted in recent years but the root idea goes back many years. In 1887 Jensen suggested leaving the crop in the ground until two weeks after the tops were dead as a sanitary measure against late blight tuber rot, and his theories were substantiated by the experiments of several workers on this continent. Paul A. Murphy, working in Prince Edward Island during the First World War, proposed cutting and removing the vines or spraying them with a chemical such as sodium arsenite or cupric sulphate. His advice was accepted by many growers in the province where killing the vines has not been an unusual procedure since Murphy's time. No investigational work was undertaken by subsequent workers until 1941 when tests to find a more effective killer were initiated.

A discoloration at the stem end and in the vascular system of tubers may be induced by killing the vines by either chemical or physical agencies, and in some regions this phenomenon is regarded in a serious light. The factor or combination of factors that may be correlated with the discoloration has not been satisfactorily determined. It is probable that more than one factor plays a part in inducing discoloration. These may include: (1) the rapidity of the kill, (2) the type of chemical, (3) the character of the season, and (4) the age of the plants.

In Prince Edward Island it has been observed that the severity of the tuber discoloration is greater when the plants are killed down rapidly and that dinitro compounds are the chief offenders. Drought also seems to favor the reaction. Experiments conducted during the past two seasons have indicated that the amount and intensity of discoloration in tubers from plants killed at different stages of development with Dowspray 66 Improved increases quite uniformly with the age of the plants. Those killed late in the season have exhibited the greatest injury.

Results of spraying and dusting potatoes for late blight. L. C. CALLBECK. Two experiments with potato late blight fungicides were conducted in Prince Edward Island in 1948 on the Green Mountain variety. One was designed to study the relative fungicidal values and the effects on yield of eight spray materials; the other was designed to compare wet and dry applications of fungicides. Seven applications of the fungicides

were made and DDT was used in all mixtures. All plots were sprinkled several times in August with water suspensions of late blight spores. These disseminations coincided with periods of abundant moisture and a severe epiphytotic was built up.

The four copper sprays—Bordeaux (4-2-40), Bordow (8-40), C. O. C. S. Niatox (4-40), and Deecop (3-40)—were of approximately equal value in controlling the disease on the foliage, Bordeaux mixture and Bordow being but slightly superior to C. O. C. S. Niatox (4-40), and Deecop. Plots sprayed with Bordeaux mixture showed the least loss from late blight tuber rot. Control differences manifested by the four organic materials were great. Dithane (1 qt. + 0.5 lbs. zinc sulphate—0.25 lbs. lime — 40) was inferior to the copper fungicides. Fungicide 629 (1—40) was worthless, whereas Parzate (1—40) and Phygon XL (1—40) were superior to all materials. Phygon XL gave outstanding control of late blight but delayed maturity. Yields were as follows: C. O. C. S. Niatox 299.1; Bordow, 294.3; Parzate, 290.8; Bordeaux, 275.4; Dithane, 257.6; Deecop, 255.1; Phygon, 254.6; Fungicide 629, 210.4; and Check, 199.5 bushels per acre.

In the second experiment dusting and spraying were compared, the materials being (1) copper sulphate-lime, (2) copper oxychloride sulphate, (3) tetra copper calcium oxychloride. Losses from late blight tuber rot were: spraying 3.0 per acre, dusting, 5.4 per acre, check 6.4 per acre. Yields were: spraying, 255.0; dusting, 225.7; and check 129.1 bushels per acre.

The effect of incorporating 2, 4-D in the regular spray on the yield of white potatoes. N. K. Ellis. The growth substance 2,4-dichlorophenoxyacetic acid can be safely included in the regular potato spray under several conditions as reported by the author. 1. Spraying potato foliage did not decrease the value of the tubers for seed the following year. 2. Single applications of as much as 2.1 pounds per acre of acid did not depress yield when the plants were 15 inches taller or more. 3. The effect of the growth substance on several varieties and the effect of time of application on the yield will be discussed.

Conversion of potatoes to stable form. Roderick K. Eskew. The chief drawbacks to the industrial utilization of white potatoes are their great bulk and perishability. The Eastern Regional Research Laboratory has been engaged therefore in the development of cheap drying methods. One process involves grinding the raw, washed potatoes in a hammer mill and drying them in a steam tube drier. Some of the dried product is continuously recycled and mixed with the ground, raw potatoes to maintain the moisture content of the material going to

the drier at 45 per cent. This prevents sticking. The product is suitable for feed or fermentation. The total cost is estimated to be about $24.00 per ton of product. This includes everything except the cost of the potatoes and selling costs.

With the addition of a sulfur dioxide treatment and other slight modifications, this process can be used to produce potato flour at a cost of about $39.00 a ton.

Pressing the ground potatoes to reduce drying costs is not recommended because of loss of potato solids.

Direct heat rotary driers are not recommended for drying ground potatoes because of starch explosion hazards. Such driers may be used, however, for sliced, raw potatoes. The sticking problem is solved by coating the slices with dried potato meal.

Cooked potatoes may be dried on double drum driers of the type commonly found in distilleries by maintaining the temperature of the feed above 150° F. The produce is suitable for potato flour.

Aphid transmission of potato virus diseases in storage. A. A. GRANOVSKY. Potato aphids normally feed on growing plants, but not infrequently are found infesting tubers in storage. This proved to be an extremely serious phenomenon, especially important to seed potato and foundation stock production. In the last few years several lots of tubers were found to be aphid-infested in storage. When planted in the greenhouse and in the field, they produced a high percentage of diseased plants, with a colony of *Myzus persicae,* which previously had fed on the leafroll infected potato plant in the greenhouse. Tubers from both lots were planted in the green house and in the field. Potatoes from uninfested lots were free from virus diseases, whereas the aphid-infested tubers produced 87 per cent of diseased plants with leafroll. It is apparent that if only a few virus diseased tubers are present in a bin, and become aphid-infested in storage, the aphids may disseminate the virus to the entire lot, thus the certified potatoes may show a high incidence of virus disease in the field the following year despite the most rigid certification measures.

Response of potatoes to rates and placement of nitrogen in Connecticut, 1948. ARTHUR HAWKINS. Nitrogen rate and placement tests were conducted with the co-operation of growers on five farms. In these experiments, plots 4 rows wide by 50 feet long were replicated six times in a Latin Square. The same amount of phosphorus and potash was applied in the row in each case, namely, 180 pounds per acre each of phosphoric acid and potash. The nitrogen application rates were 90, 120, 150 and 180 pounds per acre. Increased yields of potatoes were

obtained with each additional amount of nitrogen applied up to 150 pounds per acre at each of the five locations. These increases were not always significant. On three farms when more than 150 pounds of nitrogen were applied, decreased yields were obtained; that is, the use of 180 pounds of nitrogen resulted in less yield than when 150 pounds were applied.

At one location where Green Mountains were planted relatively early, and where the use of Dithane permitted the vines which had received higher applications of nitrogen to remain green relatively late in the season, the yields increased with increasing amounts of nitrogen up to 180 pounds per acre, the highest amount used.

In the comparisons of either 60 or 90 pounds of the nitrogen broadcast per acre and 90 in the row (with the phosphorus and potash), as compared with applying the corresponding total amount of either 150 or 180 pounds of nitrogen all in the row, there was no advantage in yields obtained from broadcasting part of the nitrogen fertilizer. In fact, on four of the five farms, decreased yields were obtained when part of the nitrogen was broadcast and harrowed in previous to planting as compared with yields obtained when the same amount of nitrogen was applied in the row.

Unusual variegations in the Sebago potato—Part II—Pathological aspects. R. W. Hougas and G. H. Rieman. Since the vine type of the double-russet Sebago was suggestive of the leaf-roll virus disease, preliminary studies were conducted to determine the possible presence of a tuber-borne virus. Mechanical inoculations, using the carborundum technique, to *Nicotiana glutinosa*, *N. rustica* and *N. tabacum* gave negative evidence. No transmission of the double-russet condition was obtained through approach grafts to white Sebago.

Scab resistance of the double-russet Sebago, under paired-row trials, was significantly greater than the variety, Russet Sebago, from which it arose. As previously reported, scab resistance of the Russet Sebago is significantly greater than white-skinned Sebago variety.

The effect of zinc-containing sprays and dusts on potatoes. William G. Hoyman. Extensive potato-fungicide experiments were started in the Red River Valley of North Dakota in 1946 to determine the effectiveness of various new fungicides in controlling the fungi causing early and late blights of potatoes. A triple lattice design, employing 6 replications, was used each year for arranging the 16 treatments. DDT was included with each fungicide and also applied to the check plot in 1948. Three year's results have shown that zinc-containing sprays and dusts increased the yields during the absence or presence of one or both of the above pathogens.

The Cobbler variety was used in 1948 and a 4-12-8 fertilizer applied at the rate of 440 pounds per acre. A trace of late blight occurred and early-blight infection was too light to observe the effect of the various materials. Dithane D-14, Parzate, Zinc Nitro-dithioacetate plus Filmfast, Tri-Basic-Nu-Z, Copper-Zinc Chromate, Tribasic Copper Sulphate and Zinc Sulphate applied the first 3 applications, the last 3 applications and during the entire season (6 applications) were used as sprays. The adjusted treatment means obtained from an analysis of variance showed the yield of each of the 8 zinc containing sprays was significant at the 1 per cent level . The dust treatments consisted of Zerlate, Z178, Parzate, Cuprocide, Tribasic Copper Sulphate, DDT, and DDT until the appearance of either bilght when Dithane D-14 was applied. The yield of Parzate was significant at the 1 per cent level while the yields of Zerlate and Z178 were each significant at the 5 per cent point. The 3 plots treated with only copper-containing fungicides did not have significant yields.

In addition to increasing the yields, the zinc-containing materials caused the vines to grow larger and remain green until frost. There was a difference, however, among the various zinc-containing sprays and dusts in this respect.

Some observations of the bunch-top (Purple-Top) disease in Canada. D. J. MACLEOD. The bunch-top (purple-top) disease found in Canada is caused by a virus which does not correspond to the type strains of the aster yellows virus and is either an aberrant strain of it or an entirely different virus. Attempts to transmit this disease by means of the leaf-hopper *Macrosteles divisus* Uhl. have been unsuccessful. The bunch-top virus was repeatedly transmitted by stem grafting from potato to potato, tomato and five other Solanum species, in all of which it produced characteristic symptoms. The tomato was found to be a useful host for expressing the virus and perpetuating it under greenhouse conditions. In potato, there is considerable variation in the symptoms expressed by this virus. Certain varieties exhibit a yellowing or purpling of the leaves and stems associated with the stunting, leaf rolling, aerial tuber formation, and wilting symptoms. In other varieties and seedlings there is no definite coloration effect excepting a slight chlorosis of the leaves in the apical region of the plant. The virus is tuber-borne but is rarely carried beyond the second generation following initial infection. Frequently only a part of the tuber is involved. Infected tubers become firm in storage and may not germinate for 12 to 30 months after detachment from the affected plants. These hard tubers sometimes remain intact in the soil during the entire growing season.

The bunch-top virus was found repeatedly in tubers and seed pieces which survived in this hardened condition in the soil. When these tubers are planted, some of the eyes fail to germinate, a few produce weak, spindling sprouts which collapse in a few days, whereas others give rise to dwarfed stalks, with enlarged nodes and axillary shoots with swollen bases which may form aerial tubers. There is also an upward rolling of the leaflets, accompanied by a yellowing and purpling of the margins, especially in the region nearest the petiole. These dwarfed stalks are rigid and brittle and sometimes remain alive from 4 to 8 weeks. More frequently, however, these stalks wilt and die in 10 to 20 days following emergence. This secondary phase of the disease resembles the condition described as 'haywire'. Wilting plants generally show a necrosis of the vascular and cortical elements in the base of the stem, the stolons and the roots. The bases of these stalks usually disintegrate and exhibit a dark brown or black discoloration somewhat resembling that associated with the blackleg disease. When the bunch-top virus was introduced by grafting to Green Mountain already bearing the leaf roll virus, a severe form of bunch-top was produced. The tubers on the plants bearing both viruses show a necrosis of the vascular elements in the stolon end of the tuber, resembling net necrosis. The flesh of the tuber in the region showing this necrosis exhibits a greenish-blue fluorescence under ultra-violet light similar to that characteristic of the compound known as scopoletin. The bunch-top virus and the leaf roll virus were found in combination in plants manifesting severe bunch-top symptoms under field conditions. The bunch-top virus was also identified as the cause of a disease in field-grown tomatoes characterized by a dwarfing and rigidity of the plant and a rolling and purpling of the leaves. The virus found in tomato induced the typical symptoms of the bunch-top disease when it was introduced by stem grafting to susceptible potatoes.

Experiences with aerial application of insecticides and fungicides. JOSEPH P. MCKENNA. The relative merits of aerial application of insecticides and fungicides as compared with ground methods is a highly controversial subject. It is not the purpose of this discussion to sustain the arguments in favor of this method, but rather to present a brief resumé of the modifying factors which affect the efficiency of aerial application and in the light of our experience, endeavor to explain the causes for poor and inefficient control.

Consideration of the physical qualities of dusts used in aerial application.

Kodachrome movie (16 mm.) depicting the organization neces-

sary for an efficient aerial application service and a study of various diluents, dusts and sprays used in this work.

Potato blight investigations. W. R. MILLS and L. C. PETERSON. Infection has been observed on many seedlings including most of the recently named varieties which previously had been considered as immune, under conditions favorable for the development of blight late in the growing season. Several new races of *Phytophtora infestans* (Mont.) de Bary, on the basis of pathogenicity, have been isolated from such plants. These new races have been found only in plots concerned with the development of varieties resistant to blight. Some of these races may be produced experimentally under greenhouse conditions. Many seedlings, if inoculated at weekly intervals with the prevalent field culture, give an immune reaction throughout their life, whereas some seedlings exhibit signs of infection beginning at the 70th day. Infection usually appears first as specks, sometimes on old leaves and at other times rather generally. Virulent cultures are obtained by culturing the organism from some of the largest lesions and by repeating the inoculations on the plant in question.

The immunity of *Solanum demissum* to all known races of *P. infestans* has been confirmed. It has been demonstrated that several genes are concerned in resistance to *P. infestans*.

Field tests of fungicide-insecticide combinations in Michigan for 1948. J. H. MUNCIE and W. F. MOROFSKY. Field trials of 21 commination fungicide-insecticide sprays and 11 dusts were carried on at the Lake City Experiment Station.

In the spray plots best control of early blight was obtained by use of copper-zinc chromate. Zerlate, Dithane D-14, Yellow Cuprocide and Cuprous oxide ranked in control in descending order among the five best materials.

Highest yield was obtained from plots sprayed with Zerlate plus CM150 (DDT) followed in descending order by Zinc nitrodithioacetate, Dithane D-14 plus zinc sulfate and lime, Parzate, micronized copper oxide (Calumet & Hecla Co.) and Dithane Z-78.

In the dust plots best control of early blight was obtained with Zerlate closely followed in descending order by Tribasic copper sulfate, zinc nitrodithioacetate and Dithane Z-78, Yellow Cuprocide, and copper-zinc nitrodithioacetate.

There were no significant differences in yield, but the highest yield in dust plots was obtained from copper-zinc nitrodithioacetate followed in descending order by Tribasic copper sulfate, Zinc nitrodithioacetate, Zerlate and Dithane Z-78.

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In another field of mixed varieties, using three dust materials, control of early blight was best with copper-zinc chromate followed by copper 8 quinolinolate and Tribasic copper sulfate.

Insect counts were made 2-4-6-8 days after each application from the 11th of July to the 9th of September.

All the spray and dust combinations gave from 95-100 per cent control of potato flea beetles. Control of aphids varied from 70-100 per cent in the spray plots, and from 69-95 per cent in the dust plots with Parathion giving the best control. Although none of the materials gave a 100 per cent control of potato leafhoppers, six-spotted leaf hoppers, spittle bugs or tarnished plant bugs, there were indications that the higher concentrations of DDT did give better results, especially on the six-spotted leafhoppers. Neither potato leafhoppers nor the Colorado potato beetles presented any serious problem during these tests.

Reaction of hybrid potato varieties to infection by Fusarium Eumartii. J. H. MUNCIE. In greenhouse trials in soil infested with *Fusarium eumartii,* of 25 hybrid seedling selections and 7 commercial varieties, only Katahdin failed to show foliage symptoms of the disease. A selection of the cross Chippewa x Menominee showed only very slight foliage symptoms. In field trials on heavily infested soil employing 24 hybrid selections and 15 commercial varieties, the Teton showed least tuber infection. Unnamed hybrid selections from the crosses 627-618 x Ostragis and Hindenburg x Katahdin, seedling 627-126 (U.S.D.A.) and Menominee showed tuber infection ranging from 11 to 20 per cent. Most of the seedling selections and commercial varieties showed tuber infection ranging from 21 to 40 per cent, whereas one seedling showed 100 per cent tuber infection.

The comparative efficiency of tuber indexing and tuber planting in the elimination of virus diseases from seed potatoes. L. T. RICHARDSON AND H. N. RACICOT. Starting with a quantity of Prince Edward Island Green Mountain seed potatoes, Certified grade, 1000 tubers were tuber indexed in the greenhouse during the winter of 1943-'44, and the healthy ones planted by tuber-unit in the field next spring. A similar 1000 tubers were planted in the field, without indexing, by tuber units (4 plants to a unit). The two plots were separated only by 3 rows of corn. Records of all viroses were taken, and the diseased plants removed as soon as possible, in both greenhouse and field. When the plots were harvested, one tuber from each plant of the remaining units was retained for the following year's experiments. During the winter, 1000 tubers from the progeny of the indexed plot were tuber indexed in the

greenhouse, and the healthy ones planted by tuber units in the field the next spring. One thousand tubers from the progeny of the tuber unit plot were planted by tuber units, but without indexing, in the field the next season. This procedure was repeated 5 times. The percentage of virus diseases eliminated by tuber indexing in the greenhouse each year was 1.8, 4.5, 7.5, 2.2 and 1.4. The percentage of virus diseases occurring in the resulting healthy stock growing in the field each year was 1.6, 1.0, 1.5, 0.6, and 2.6. The percentage of virus diseases occurring in the tuber unit plot each year was 2.7, 3.9, 29.9, 8.9, and 16.4. Under Ottawa conditions, tuber indexing was more efficient in eliminating virus diseases than tuber unit planting.

Utilization of potatoes. Production of useful fermentation products. R. H. TREADWAY AND T. C. CORDON. Two-thirds to three-fourths of the solids content of the potato is starch, which can be converted to the sugars maltose and dextrose. These sugars may in turn be fermented to produce a series of alcohols, acids, and other organic compounds or may be used for the production of protein by propagation of feed yeast.

In the last few years, a large quantity of surplus potatoes has gone into the production of ethyl and butyl alcohols. With the object of extending the list of compounds which can be produced from potatoes, an investigation was made of their use in lactic acid fermentation. Lactic acid is at present made in the United States by fermentation of starch hydrolyzates, dextrose, lactose, or sirups. The acid, which is currently manufactured at the rate of approximately 6 million pounds a year, promises to become a large-tonnage chemical because of important existing and potential uses.

In preparing lactic acid, the potatoes were washed, ground, and then thoroughly cooked. The starch in the cooked potato was converted to sugars with amylase produced by the mold *Aspergillus niger*. Three strains of *Lactobacillus* were used in the fermentation, the best results being obtained with a strain of *L. pentosus*. Although it is common practice in commercial manufacture of lactic acid to use added nutrients, yields of 80 to 90 per cent lactic acid (based on the available carbohydrate) were obtained in the fermented mash without added nutrients. About 85 per cent of the acid in the mash could be recovered as methyl lactate. Potato mash was used as the culturing medium for the amylase-producing mold and for the *Lactobacillus,* as well as for supplying carbohydrate for the fermentation.

Preliminary studies indicate that feed yeast can be propagated on potatoes. The yeast uses carbohydrate and nitrogen to produce cell protein. The nitrogen is added as ammonia, ammonium salts, or urea.

1. Report of a study in which certain phases were carried on under the Research and Marketing Act of 1946.

Unusual variegations in the Sebago potato.—Part I—Somatic mutations. W. H. WEBSTER AND G. H. RIEMAN. A clonal line of the Sebago potato variety grown since 1943, has exhibited a high degree of instability. Three different types of tuber russeting and two abnormal vine characters have arisen which can be propagated asexually.

The abnormal vine type, producing double russeting of the tubers, resembles to some extent the symptoms of a potato plant infected with the virus causing leaf-roll.

Reversion of the abnormal vine types to normal occurs frequently and is always accompanied by a change to single russeting of the tubers.

Effect of the leaf roll and X viruses on stand and yield of potatoes. R. E. WILKINSON AND F. M. BLODGETT. Replicated factorial experiments designed to determine the effect of the leaf roll and X viruses in Katahdin, Chippewa, and Sebago varieties of potatoes were planted in 1947. The virus diseases were present as the result of natural infection. All tubers came from the same field the previous year, were stored under the same conditions, and were indexed in the greenhouse during the winter for the presence of virus diseases.

The Katahdin and Chippewa plots had 90 per cent of a full stand and the missing hills were scattered at random. The principal effect of the virus diseases appeared in the yield. The virus-free plots produced a yield of 365 bushels per acre. The X virus in the absence of leafroll caused a reduction of 23 bushels per acre, but in the presence of leafroll of 74 bushels per acre; whereas leafroll gave a reduction of 95 bushels in the absence of X virus disease and of 146 bushels in the presence of X virus; or, both diseases together gave a reduction of 169 bushels per acre. With the exception of the reduction due to X disease in the absence of leafroll, these reductions are highly significant and the interaction between the two diseases is also significant.

In the Sebago variety, in addition to an effect on yields, there was a marked effect on the stands. From the 60 seed pieces planted in each, 40 hills grew from healthy sets; 20 from those with X virus; 34 from those affected with leafroll; and 13 from the sets affected with both X and leafroll viruses.

SECTIONAL NOTES

ALABAMA

The commercial potato section of Alabama has planted 245 cars of seed. Baldwin County planted 200 and Escambia County some 45 cars. Despite the seemingly lack of interest in potatoes during the winter, this planting is at least 50 cars more than expected earlier. Last year there were more than 300 cars planted in the two counties so we have a reduction of nearly 20 per cent in our total planting. Our estimate varying between 13,000 and 13,500 acres will not be so far from the total number of acres planted. That compares with about 16,000 acres for last year. Of this planting more than 70 per cent will be Bliss Triumph and the balance Sebago.

We have had a peculiar weather condition this winter. In fact, we have had very little winter at all. During the month of February the temperature did not reach the freezing point. Because of this condition we have potatoes anywhere from just emerging to those with small potatoes. Today, the 1st of March, we missed a frost by a few degrees but there is considerable worry over probable frost damage at a later date. So far this season we have missed the heavy rains that leach our fertilizer, but March weather is usually bad with us in this respect.

The papers have announced a support price of $2.00 per hundred for all grades of potatoes this season. That is graded and in car. That means that our farmers will probably get about $1.50 per 100 pound sack if support has to be used. We are always hoping that we can move the crop above support. Most of our growers should be able to secure small profit at this price but there will be no getting rich. We must expect for things to get back to normal sooner or later and take the good with the bad.—FRANK E. GARRET

MAINE

Maine potato farmers took a straight 23.6 per cent reduction in acreage from their 1948 goal. This policy was determined by the P. and M. A. Committee and Aroostook farmers have just received their allotments. There is some grumbling but on the whole farmers have realized the situation and are apparently going along with the program. Maine has always participated better than 90 per cent in such programs and there is nothing now which would indicate that they will not go along at that same ratio.

This acreage cut brings Maine back to their 1942 potato acreage. Any further cut another year will apparently meet much resistance.

To date (March 7th) Maine has shipped 40,700 of which the government has purchased 26,562 cars. Because some of these cars were loaded heavily last fall it would be the equivalent of well over 30,000 cars purchased by the government.

The industry is up in arms about Canadian imports as much of the Canadian stock competes with Maine markets. Farmers cannot understand why the government allows Canadian potatoes to enter, for the U. S. is under a price support program with acreage control. Canada has no such program so the U. S. is really supporting the price of Canadian potatoes.

Hundreds of letters from all over the country have been recently received from the Kennebecs. Practically all of the Kennebecs were in the hands of the State Seed Board. These have been allocated in small lots to some of the better growers who have excellent records as seed growers. These will be multiplied under very careful supervision this year. The State Department of Agriculture and the Extension Service are again promoting a Blue Tag Certified Seed Campaign to have every one plant certified seed in 1949. A new colored poster is being placed in potato houses throughout the county so that farmers will constantly be aware of the fact that certified seed last year outyielded table stock by 44 bushels per acre. Last year 85 per cent of all the potato acreage was planted with certified seed. It will be difficult to exceed this but every effort will be made to do so. Plans are being made for the Farm Bureau Field Day at the Experiment Station, Presque Isle for the 10th of August, 1949.

—VERNE C. BEVERLY.

NEW JERSEY

Many growers in New Jersey are still undecided in regard to the acreage of potatoes that they will plant this year. Some growers feel that they cannot produce potatoes on the small acreage allotted and have decided to take a chance on good prices and plant their normal acreage. Others have decided not to overplant because of the danger of market prices being considerably below the cost of production and still others have decided not to grow any potatoes this year.

Weighing these possible actions, indications are that slightly fewer growers will comply with the goals recently released as compared with goals released in 1948.

Preliminary indications to plant released by the State Department of Agriculture are set at 43,000 acres whereas 54,000 acres were planted last year.

We have had a very mild winter and growers are now cutting seed and getting their fertilizer in order to be ready to plant at the earliest possible date. Some growers like to start by the 17th of March but large scale planting is not likely to start before the 1st of April.

There is considerable interest in methods of increasing yields and some of our growers are planning on closer seed spacing, and fertilizer side dressing as a means of accomplishing this end.—JOHN C. CAMPBELL

NEW YORK

Marketing agreements are receiving a lot of attention in both up-state and Long Island. The Long Island growers have had several meetings on agreements for their territory with no definite action, more than the appointment of committees to study the matter further.

In up-state New York, the directors of the Empire State Potato Club, the State Farm Bureau Federation Potato Committee and the P. & M. A. Potato Committee have been delegated with the responsibility to draw up a Marketing Agreement that would fit New York and submit it to the growers through meetings *etc.* after the committee has agreed upon a plan.

The new Support One Price Program is regarded as a big help in instituting Marketing Agreements. The two objections to Marketing Agreements have been disposition of the low grades and the enforcement. With an outlet for low grades, enforcement will be much easier.

Acreage cuts of approximately 20 per cent have been indicated for up-state growers and about 30 per cent for Long Island. The Long Island allotments may be issued but on the 1st of March the up-state allotments had not been announced and many growers are much in doubt about their acreage. However, the tendency is to go along with the program because our growers realize that potatoes have gotten to be a problem which must be handled with considerable thought and consideration from all standpoints. They recognize too that the individual program must be a part of a larger program for the benefit of all.

Markets vary from fair to steady with prices somewhat below support generally. With local markets our growers are attempting to market a good percentage of their crop themselves with a minimum of outside help. However, the government is getting plenty of potatoes. —W. H. EVANS

NORTH CAROLINA

As a result of unseasonably warm weather, Irish potato growers in eastern North Carolina began planting their crop in early February. A number of growers in the Beaufort and New Bern areas completed

their plantings about the 20th of February. The rainy period during the latter part of the month has slowed plantings in other areas. By far the largest proportion of the acreage will be planted with the Irish Cobbler variety. Small plantings of Katahdin and Sebago will be planted in some areas.

The North Carolina potato acreage for 1949 was cut 25 per cent below that allotted for 1948. The allotted acreage for 1948 is 20,500 acres. At a meeting of the eastern North Carolina potato growers on the 12th of February in Washington, N. C., growers expressed views favoring an across-the-board cut for all potato growing sections of the country; *i.e.*, if one area is cut 20 per cent or more, all areas should be cut the same. Also, they maintained that the support price should be uniform for all areas for a given period. Opposition was expressed toward the 20 cent differential in the support price during June between North Carolina and other areas sending potatoes to the market during that month. Under the present provisions of the program, North Carolina will receive $1.70 per 100 pounds in June whereas during the same period competing areas will receive $1.90.

It is expected that a greater number of precooled cars of potatoes will be shipped out of North Carolina this year than in previous years. With an increase in the number of washing machines being installed in the eastern potato growing area of North Carolina, a higher percentage of the crop will be washed in 1949. In an effort to improve the handling of potatoes during harvesting, grading and preparation for shipment, schools are to be conducted in twelve localities in the eastern potato areas of the state.

Potato planting proceeded from the 28th of January to completion in mid-February under the best weather conditions on record. The temperatures remained above normal until the 1st of March at which time 20 to 25 per cent of the plants had begun to emerge. The low temperatures during the first three days of March cut down most of these small plants except for plantings that were adjacent to the rivers and ocean. This should not prove any great factor as there is still plenty of time for these plants to make a normal growth and produce a good yield.

With the advent of washing machines in this area the variety picture has changed radically. The Cobbler variety has dropped from 85 to 90 per cent of the acreage; 10 years ago to 35 per cent; 2 years ago and on to approximately 12 per cent. Practically all this is planted in outlying areas where washers are not available. Red Bliss and Pontiac acreages total about 12 to 15 per cent, with greater acreages

of Bliss because this variety washes better than Pontiac. The Katahdin acreage increased gradually up to last year when it occupied about one-third of the plantings but it has dropped to approximately 25 per cent this year, largely because it does not wash so well as Sebago. Because of its shape, color, freedom from browning *etc.* which result in such an excellent washed product, Sebago plantings have increased from insignificance five years ago to at least 50 per cent of the state acreage this year and in the area adjacent to the washers it occupies nearly three-fourths of the plantings.

Growers gladly reduced the acreage in accordance with this allotment and until recently were pessimistic about the prospects of making any profit on the crop. Unfavorable weather conditions in other parts of the country have lifted their hopes somewhat and interest in controlling insects and diseases and washing and marketing problems have increased greatly during the past few days.—W. C. Barnes

Texas

This section suffered a severe freeze on the 31st of January which caused much damage to the potato crop. We estimate that approximately 15 per cent of the crop was almost a total loss; about 70 per cent will make about half a normal crop, and approximately 15 per cent of the late plantings have suffered no damage.

This county has not entered into a marketing agreement. The new support program has met with much favor. As a result the top grades, will go to consumers and the lower grades into conversion channels.—Cleve H. Tandy

Canada

Following an exceedingly large crop of potatoes in Eastern Canada, many bushels of both table stock and seed were shipped to the United States. The United States Government feeling that their markets might be flooded and their support program disrupted, asked Canadian Government officials to discuss the matter with them. After negotiations between the Governments of Canada and the United States, relative to the movement of potatoes, the following agreement was reached:

1. That, after the 1st of December and applying to the 1948 potato crop, Canada would not ship any table potatoes to the United States.

2. Certified seed potatoes would be shipped to the United States only under permit and on the time basis; that is, permits would be issued for potatoes going from Canada to the United States only a short time before the planting date in the area to which the potatoes were

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destined. This control of the potato movement has worked out very satisfactorily to all concerned, and Canada is continuing to move quantities of certified seed into the markets they have been serving for many years. Permits have been rendered freely when the shipper attaches a statement to his application to the effect that these potatoes would not be diverted or reassigned for table purposes.

At the same time that the agreement was made with the United States, the Canadian Government issued a price support program for Canadian growers in Prince Edward Island and certain large commercial shipping centres in New Brunswick. The Canadian Government has agreed to pay $1.15 per cwt. for Canada No. 1 (table) potatoes in the bin on the farm as of the 1st of April, 1949. Although some growers have felt that this support price is rather low, many growers feel quite satisfied, as the price of potatoes at present is slightly higher than the government offers, and, at the same time, the potatoes are moving freely.—J. W. SCANNELL

ERRATUM

The illustration on page 49 of the February, 1949 issue was inserted by mistake.

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A PROGRESS REPORT ON THE CHIPPING QUALITY OF 33 POTATO VARIETIES[1]

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AND

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Introduction

Varieties of potatoes vary considerably as to their suitability for the commercial manufacture of potato chips. However, comparatively little study has been made of the performance of different varieties, or effort made to breed varieties more suitable for this purpose than those now available. The potato chip industry is of growing importance; it used about 20 million bushels for chip making, the past season. Potato chippers experience a great deal of difficulty in obtaining suitable raw

[1]Report of a study made under the Research and Marketing Act of 1946.
[2]Physiologist.
[3]Associate Horticulturist.

stock, especially during late winter and spring or after potatoes have been in storage a few weeks after digging. The many inquiries addressed to this Department have prompted an investigation of the suitability of different varieties from different localities, and of different methods of storing and handling potato stocks for chipping purposes.

Acceptable chips can be made from almost any variety of potato during the first few days after harvest; but after a few weeks of storage even at a favorable temperature certain varieties undergo changes that cause them to develop an undesirable brown color when made into chips, although they may be entirely suitable for table use. Some varieties remain useful for chipping as long as they are kept at a temperature of approximately 50° F. or slightly higher; but they lose their usefulness if stored at temperatures much below this, and it is difficult or impossible to restore them to their original usefulness.

Potato storage houses in the North seldom remain as warm as 50° for very long after harvest. Probably in most areas where potatoes are stored extensively the storage house temperature reaches at least 40° to 45° by the end of October, with a range of 35° to 40° thereafter until spring. Certain other varieties are not especially "temperamental" or sensitive to cold. These do not readily get out of condition, but recondition readily when stored at about 70° to 80° for one or more weeks. The latter group of potatoes is most useful to the chipper because of its dependability for making a desirable product, especially late in the season when the other varieties cannot be used.

Experimental

This report covers two seasons' work with 33 varieties of potatoes obtained through the cooperation of the Potato Section of this Bureau. These included some older standard commercial varieties, several new varieties, and a few unnamed seedlings. All were grown at Presque Isle, Maine, on the same general type of soil, thus affording an opportunity for direct comparison of varieties grown under the same climatic conditions. Shortly after harvest they were shipped to the Beltsville laboratory where the lots were divided, and part of each was stored at 55° F. and part at 40°. Chips were prepared from the 55° storage lots after approximately 2 months. After about 3 months those stored at 40° were moved to 70° for 22 days and then made into chips. A uniform procedure was followed when cooking all lots. Ten representative tubers from each lot were sliced into uniform slices approximately 3/64 of an inch in thickness. A few slices from each

tuber were selected to make up a composite sample of 200 grams which was rinsed to remove excess starch, blotted between towels and then cooked in peanut oil at 340° until all water was expelled as indicated by cessation of bubbling. At the finish the oil temperature was 320°.

Salability based on the color of chips from 33 varieties of Maine-grown potatoes after storage at 55° F. and after conditioning at 70° for 22 days following storage at 40°.

Variety	Salable; from 55° Storage[1]	Not Salable; from 55° Storage	Conditioned Satisfactorily 40-70°	Conditioned unsatisfactorily 40-70°
Calrose	X		X	
Cayuga	X		X	
Chippewa	XX		XX	
Earlaine	X		X	
Earlaine 2		X		X
Erie	X			X
Green Mountain		X		X
Houma	X			X
Irish Cobbler	X		X	
Kasota	X		X	
Katahdin	X		X	
Kennebec	XX		XX	
Menominee		X		X
Mesaba	X			X
Mohawk		X		X
Netted Gem	XX		XX	
Norkota	XX		XX	
Pawnee	X		X	
Pontiac		X		X
Potomac		X	X	
Red Warda		X		X
Russet Rural	XX		XX	
Rural New Yorker	XX		XX	
Sebago	XX		XX	
Sequoia		X		X
Teton	XX		XX	
Triumph		X		X
Warba		X		X
White Rose		X		X
B61-3	X			X
B69-16	X			X
47258	X		X	
24642		X		X

[1] X Signifies acceptability.
XX Signifies outstanding attractiveness.

The results of two seasons' study are combined in the accompanying table. In the first column are shown the varieties from 55° F. storage which produced chips that were rated salable or better. This

group includes those that just make the salable grade—the chips being somewhat dark brown but usable, especially if mixed with lighter colored stock—and those that were of outstanding attractiveness, being of a uniform light golden color. Those of less attractiveness are indicated by X and those of greater attractiveness by XX. In the second column are shown those varieties the chips of which did not rate as salable. In the third column are given the varieties that could be successfully conditioned at 70° after being transferred from 40°. The chips made from these are rated as having greater or less attractiveness, as in column one. In the last column those varieties that could not be satisfactorily conditioned are indicated.

Summary

Thirty-three Maine-grown varieties of potatoes were studied to determine their comparative suitability for use in chip-making. In this study the varieties that proved to be unsuitable for chip-making, since they did not make a salable product even when stored at 55° F. or could not be satisfactorily conditioned (desugared) at 70° following storage at 40°, were Earlaine 2, Green Mountain, Menominee, Mohawk, Pontiac, Potomac, Red Warba, Sequoia, Triumph, Warba, White Rose, and Seedling 24642.

Varieties from 55° F. storage that produced chips of salable grade but not considered of outstanding attractiveness were: Calrose, Cayuga, Earlaine, Erie, Houma, Irish Cobbler, Kasota, Katahdin, Mesaba, and Pawnee. These varieties also produced chips of salable but not outstanding grade when conditioned, with the exception that Erie, Houma, and Mesaba could not be satisfactorily conditioned after storage at 40°.[1]

Varieties that produced chips of outstanding attractiveness after storage at 55° F. and after conditioning at 70° following storage at 40° were: Chippewa, Kennebec, Netted Gem (Idaho Russet), Norkota, Russet Rural, Rural New Yorker (Smooth Rural), Sebago, and Teton.

POTATO STORAGE: EFFECT ON THE PASTE VISCOSITY OF THE STARCH

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When potato starch is heated in water the starch granules swell enormously, forming a paste. The viscosity of even 1 per cent potato starch paste may be several hundred times that of the water. To a large extent the industrial usefulness of potato starch depends on the viscosity of its pastes. High viscosity is usually associated with starch of good quality, and is taken as an indication that chemical, bacterial, and thermal deterioration of the starch during manufacture and storage has been avoided. Potato starch is sensitive to seemingly trivial changes in composition and environment, and its pasting properties sometimes greatly change simply on keeping the air-dry starch at room temperature for a few days or weeks (7).

Normal operation of a potato starch factory extends for several months beyond the harvest season. During this time the stored potatoes may lose a substantial part of their original starch. As the first step, the starch is presumably reduced to a soluble form, sugars. Then these are oxidized to carbon dioxide and water, the extent depending on the temperature, and eliminated by the ordinary process of respiration. At temperatures near the freezing point, the oxidation is relatively slow, with the result that sugars accumulate in the potato at the expense of its starch. If subsequently kept for a week or two near room temperature, much of the sugar is reconstituted into starch by the same enzymes in the potato that synthesized the starch while the potato was growing on the vine. It might reasonably be expected that the partial destruction and partial resynthesis would change the growth structure of the granules sufficiently to alter the properties of the paste and thus the quality of the starch. That this occurs has been implied by Katz (2), but no experimental test was reported.

The present paper reports on the paste viscosity of starch extracted from Green Mountain potatoes grown at Aroostook Farm, Presque Isle, Maine, and stored there at 34°, 42° and 50° F. for periods up to nine months. Changes in the starch and sugars contents of the same lots of potatoes have been determined by Treadway, Walsh, and Osborne (5).

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Materials and Methods

Five-pound samples of potatoes were taken from storage at approximately seven-week intervals. A period of seven to ten days, during which the temperature was 60°-70° F., then elapsed before the starch was extracted. The potatoes were peeled manually, with an average loss in weight of 13 per cent. They were chopped and passed twice through a hammer mill, and the pulp was diluted and screened through 40- and 80-mesh sieves. The starch was tabled twice, passed through a 150-mesh screen, settled, and dried at 70° F. to a moisture content of 10 to 12 per cent. All water added was distilled water, and no sulfur dioxide or other preservative or bleaching agent was used.

The viscosity of 3.5 per cent pastes in distilled water was measured at 192° F. for periods varying to three hours. The pastes were stirred at 10 r.p.m. with a broad, slotted paddle to maintain a uniform temperature, and thus consistency, throughout the one-liter volume of paste. Measurements were made with a Brookfield viscosimeter; rotors 3 and 4 and a rotor speed of 30 r.p.m. were used. Reproductibility of data was usually better than 5 per cent, and often better than 1 per cent. The viscosity data indicate apparent viscosity only. They are reported in poises as computed from the instrument readings.

Results

Starch Recovery. The yield of moisture-free starch ranged from 12.2 to 14.7 per cent of the weight of the pared potatoes. The proportion of starch recovered to the total amount, as measured by Treadway, Walsh, and Osborne (5), varied from 78 to 86 per cent. Essentially no change in the efficiency of extraction was associated with either the temperature or duration of storage. Starch was as fully recoverable from the excessively sprouted and withered potatoes stored at 50° F. as from sound potatoes stored at 34° F. The smaller quantities of starch recovered from the latter samples (averaging 12.4 per cent) in comparison with that recovered from potatoes stored at 42° and 50° F. (averaging 13.6 and 13.8 per cent) were related to the lower starch content (5).

Analytical Data; Whiteness. Analysis of a typical starch showed the following: nitrogen, 0.01 per cent; fat, 0.03 per cent; ash, 0.22 per cent; calcium, 0.0037 per cent; and phosphorus, 0.071 per cent. Only in whiteness were the laboratory starches inferior to an excellent grade of commercial starch. The difference is expressed by the diffuse reflectance for blue light (wave length 4500 angstrom units) compared

with magnesium oxide: commercial potato starch, 91 per cent; typical laboratory starch, prepared without sulfur dioxide, 83 per cent.

Viscosity. Starch paste viscosity arises principally in the resistance to flow offered by the swollen starch granules. Potato starch granules swell to an extraordinary extent, with the inevitable result that the boundary membranes or envelopes are extremely thin. The granules are then easily disrupted by solution of the starch membrane in hot water, or mechanically, by stirring or other motion of the paste. By such processes, the average bulk of the swollen granules continuously decreases, and correspondingly the viscosity falls. In the present experiments the viscosity decrease amounted to approximately 50 per cent in two hours at 192° F.

In table 1 the viscosity of 3.5 per cent pastes at a pasting time of 60 minutes is compared. The data show that starch quality, as indicated by viscosity, is not lowered by prolonged storage of the potatoes. Viscosity differences are most pronounced in starch prepared from potatoes stored at 34°, and the viscosity shows fluctuations rather than

TABLE 1—*Viscosity of starch from stored potatoes*

[Measurements made on 3.5 per cent pastes in distilled water at 192° F; 60 minutes pasting time. Viscosity for starch extracted from potatoes at beginning of storage period, 46 poises.]

Temperature of Storage, °F.	Viscosity of Starch from Potatoes Stored for (Weeks)				
	7	13	22	29	37
	Poises	Poises	Poises	Poises	Poises
34	34	54	61 (13)[1]	50	72
42	66	66	67	68	71
50	55	73	69	64 (13)[1]	69

[1]Pastes made with tap water.

a trend. Starch from potatoes stored at 42° and 50° is of substantially equal quality. With two outstanding exceptions, the variation in viscosity in the whole group of starches is relatable to the pH and calcium content. The range of pH was 5.64 to 6.52, and the range of calcium content, 0.0028 to 0.0059 per cent. The viscosity values in table 1 are, roughly, in direct proportion to starch pH and in inverse proportion to the percentage of calcium. Thus an increase of one pH unit raised the viscosity about 28 poises, and an increase of 0.001 per cent in calcium diminished the viscosity by about 8 poises. This leads to the expectation that the starches, if made equal in pH and content of calcium, would

show equal viscosity also. The two starches with lowest paste viscosity, 34 and 46 poises, were the first to be extracted, and were obtained respectively from potatoes stored seven weeks at 34° and from the original or non-stored potatoes. Both starches had a somewhat musty odor. The subnormal viscosity is possibly due to microbial spoilage during the preparation, which kept these starches moist for an appreciably longer time than the starches subsequently prepared.

Effect of Water Quality on Viscosity. A notable feature of the data in table 1 is the decrease in viscosity from more than 60 to 13 poises caused by pasting with tap water rather than distilled water. This is doubtless an electrolyte effect, analogous to the pH and calcium effects already mentioned but of much greater extent. The predominant importance of electrolytes in determining the paste viscosity of potato starches is illustrated further in experiments with an excellent grade of commercial potato starch. The results are summarized in table 2.

TABLE 2—*Effect of water quality on the viscosity of high grade commercial potato starch*

[Measurements made on 3.5 per cent pastes after 60 minutes pasting at 192° F.]

Treatment	Viscosity
	Poises
Starch pasted with distilled water	18
Starch pasted with tap water	8
Starch washed four times with distilled water, then	
a. Pasted with distilled water	36
b. Pasted with tap water	10
c. Pasted with distilled water containing 50 p.p.m. calcium chloride.	13

These results show that the viscosity of the commercial starch pasted in distilled water was only one-third to one-fourth that of the normal laboratory starches. This low viscosity was reduced considerably further by pasting with tap water. Washing the starch with distilled water and then pasting with distilled water increased the viscosity to 36 poises, double the original viscosity. Pasting the washed starch with tap water reduced the viscosity to 10 poises; and pasting with water containing 50 p.p.m. calcium chloride resulted in a viscosity of 13 poises. The pH of the commercial starch was 6.50 before washing and 6.38 after washing; its respective calcium contents were 0.057 and 0.052 per cent. The distilled water wash, then, removed 0.005 per cent of calcium, equivalent to about one-tenth of the total amount present, and simultaneously raised the viscosity 18 poises.

Discussion

The potatoes used in this work lost approximately 30 per cent of their starch while in storage (5). This figure was obtained on potatoes immediately after withdrawal from cold storage. In the two-week interval before extraction of the starch, part of the sugar had been reconstituted into starch and part eliminated by respiration. Our viscosity data imply that this change did not alter the granule structure or the starch molecules within it sufficiently to change the swelling capacity of the granules or to change the stability of the swollen granules toward dissolving, mechanical breakage, or loss in volume by diffusion into the pasting medium.

Sensitivity of potato starch paste viscosity to electrolytes has been noted previously (3, 4, 7). A quantitative explanation cannot yet be given. The electrolyte sensitivity is due to the small amount of phosphoric acid chemically combined with the starch molecules. The acidic properties of this starch-phosphoric acid closely resemble those of orthophosphoric acid, H_3PO_4 (1). This means that at pH about 6.5 the two ionizable hydrogens of starch-phosphoric acid are on the average three-fourths replaced by metal ions. In the potato and in starch extracted with pure water, the metal ion is principally potassium (6), but this is readily displaced by the calcium and magnesium ions contained in the surface or ground water ordinarily used by potato starch factories. Potassium starch ionizes when pasted, leaving a considerable negative electric charge on the granules. Calcium starch ionizes much less because calcium is bound tightly to the phosphoric acid groups. Correspondingly, the negative charge on the granules is less. It appears that the ability of potato starch granules to imbibe water and swell is determined largely by the charge. Reagents that decrease the charge decrease granule swelling and thus the viscosity of potato starch pastes. Much of the variability reported for potato starches may be ascribed to the neglect of small amounts of electrolytes.

It may be conjectured that seasonal changes in commercial potato starch quality such as indicated by Katz are actually more a reflection of seasonal changes in the amount or composition of the mineral content of the processing water than differences in the starch itself.

Summary

The quality of potato starch, as indicated by paste viscosity, was not affected by storage of the potatoes for periods up to nine months at temperatures of 34°, 42°, and 50° F. The composition of the water

used in extracting the starch is of considerably greater importance in determining starch quality.

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RING ROT OF POTATOES[1]

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Part I—Rate of spread of the organism and losses incurred by infection with *Corynebacterium sepedonicum* (Spieckermann and Kotthoff) Skaptason and Burkholder.

Ring rot of potatoes was definitely recognized in Idaho, during the growing season of 1939, in the early producing areas of the state. Observations indicated that this disease was present in the areas earlier and that importations of infected seed were responsible for its occurrence in such areas. The disease was something new to all parties concerned and was of much concern to producer, shipper, and investigator alike. A program of investigational work was therefore instituted. Among the matters investigated were such as effectiveness of various chemicals as seed disinfectants, and knife disinfestants; the use of a rotating disc seed cutting knife; a comparison of assist-feed planters *vs.* picker-type planters in disseminating the causal organism; the rate of increase of infection in a crop that was grown from seed with known amounts of infected seed pieces in it and the relation between percentage of disease in a crop and the resulting reduction in yields.

[1]Published with the approval of the Director of the Idaho Agricultural Experimental Station as Research Paper No. 287.
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This paper is to report on those phases of the program relating to the rate of increase of infection in a crop grown from seed with known amounts of infected seed pieces in it; the relative ability of picker and assist-feed types of planters in spreading the organism; and reduction in yields of marketable tubers, in crops with known amounts of disease in them. Bonde and Merriam (1) have shown how, with varying percentages of infected seed pieces in the original seed, the amount of disease will increase through a period of three years. Unlike the Maine tests, this paper deals with yearly increases in amount of disease.

Experimental Procedure

1. *Seed*

The planter test was conducted in 1943. Clean cut and single drop seed was used. Each treatment was replicated twice; each replication consisting of a row of approximately 100 plants. The planters were contaminated before planting by rubbing diseased tubers over the planting plates and platform of the assist-feed planter and jabbing the pickers of the picker planter with an infected tuber.

In 1944 and 1945, five lots of 100 Russet Burbank tubers, containing 1, 3, 5, 7, and 9 per cent of infected tubers respectively, were halved. Thus, each lot contained 200 seed pieces in which the percentage of infection was not altered. The tubers were cut with a non-sterilized rotating disc cutting knife. In each lot the first tuber to be cut was infected; in Lot II the 33rd and 66th were also infected. The tubers in the remaining lots were cut in a comparable manner according to the following plan:

Lot	Per cent of Tubers Infected	Order in Which Infected Tubers Were Cut
I	1	1
II	3	1-33-66
III	5	1-20-40-60-80
IV	7	1-14-28-42-56-70-84
V	9	1-11-22-33-44-55-66-77-88

The same general plan that was followed in 1944 and 1945 was again used in 1946, except that lots of seed containing 2 and 10 per cent infected tubers were also included. The seed for 1946 was cut in the following order:

Lot	Per cent of Tubers Infected	Order in Which Infected Tubers Were Cut
I	1	1
II	2	1-51
III	3	1-33-66
IV	5	1-21-41-61-81
V	7	1-14-28-42-56-70-84
VI	9	1-12-23-34-45-56-67-78-89
VII	10	1-11-21-31-41-51-61-71-81-91

Each year, the infected seed pieces were allowed to remain in the seed and were planted with the remainder of the seed of each respective lot. Planting was accomplished with an assist-feed planter. The planter was thoroughly disinfected between the planting of each lot. The seed for each treatment was planted in one row.

2. *Recording Results*

For the planter test, counts were made on three separate occasions during the season and on the day of each count, the diseased plants were eliminated. The stain test was not used in connection with this portion of the experiment.

In 1944, four 25 consecutive-hill units were staked off, at random, in each row, upon which data were collected. During the season the plants were examined twice and the plants of all hills showing aerial symptoms were eliminated and the numbers recorded. The remaining hills were dug by hand at harvest time and separately bagged for later examination.

In 1945 and 1946, five 10 consecutive-hill units were staked off, at random, in each row, upon which data were collected. At harvest time, each hill was separately dug by hand, and the tubers bagged for later examination.

The Grain-stain test was used in accordance with Racicot, Savile, and Conners (2) to ascertain the number of hills which were involved with ring rot. A separate smear was made for each No. 1 tuber of each hill. A composite smear was made of the culls of each hill. If a single smear of any of the progeny of a hill was gram positive, the hill was considered as being diseased. The weight of the disease-free No. 1 tubers, of each, was recorded.

3. *Losses*

Observations had shown that there is not always complete loss of the crop when a hill is involved with ring rot. If the attack is early in the development of the plant, it, in all probability, will be killed. In cases of late development of the disease, there will generally be some production of marketable tubers. It was determined, therefore, to correlate known percentages of disease in the crop with losses.

The 1944 and 1945 tests were so set up that by rearranging the data obtained, it was possible to secure categories of 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 per cent disease. Yields of disease-free marketable tubers were recorded for each ten-hill replicate. It was therefore possible to compare the yields secured in the various categories, where there were known amounts of disease, with the yields secured in that category where there was no disease.

Results

1. *Rate of Spread*

The results obtained in the planter test conclusively showed the picker type of planter to be an efficient means in spreading the organism. In table 1 can be found data showing the relative ability of the two types of planters in this regard.

TABLE 1.—*Comparison in the ability of assist-feed and picker types of planters in spreading Corynebacterium sepedonicum.*

Replication	Treatment	Stand	Ring Rot Counts			Total Disease
			1	2	3	
1	Check-clean cut seed,	88	0	0	0	0
2	clean assist-feed planter.	114	0	0	0	0
1	Clean cut seed, infested	100	0	0	0	0
2	assist-feed planter.	98	0	0	0	0
1	Clean single drop seed, in-	93	0	0	0	0
2	fested assist-feed planter.	89	0	0	0	0
1	Clean cut seed, infested	88	12		23	35
2	picker planter.	77	12		19	31
1	Clean single drop seed,	96	0	0	7	7
2	infested picker planter.	86	12	4	37	53

Since the stain test was not used to determine whether any of the remaining hills were diseased, it should be apparent, from data presented later in this paper, that more of the hills could have been diseased, probably some of those planted with the assist-feed planter.

The value of using seed stock free from infection is clearly indicated in table 2. In this table can be found data showing how rapid the organism will spread by such means as the cutting knife and that

small amounts of infected tubers in seed are the source of much loss in the subsequent crop when such seed is used.

TABLE 2.—*Data showing rates of increase of ring rot in subsequent stand when seed contains* 1, 2, 3, 5, 7, 9, *and* 10 *per cent of infected tubers.*

Per Cent Infected Tubers in Seed	*Percent Diseased Hills in Subsequent Crop*		
	1944	22	1946
1	58.4		24*
2		56	8
3	72.4	54	38
5	88 9	74	44
7	84.0	72	50
9	84.3	1945	58
10			70

*This row was over-irrigated resulting in considerable water rot, which confused the picture.

In 1944 and 1945, the results obtained were based on field inspection and the stain test. In 1946, diagnosis for the presence of the causal organism was based entirely on the satin test.

To test the reliability of basing diagnosis on the presence of aerial symptoms only, the following data are presented to show that presence of aerial symptoms is not completely reliable as is shown in table 3.

TABLE 3.—*Inadequacy of the presence of aerial symptoms in diagnosing for the presence of ring rot in a stand of potatoes.*

	Symptom Group			
	No Visible Symptoms, Negative Stain	No Visible Symptoms, Positive Stain	Visible Symptoms, Negative Stain	Visible Symptoms, Positive Stain
No. of Hills	271	85	0	98

It is evident that the lack of aerial symptoms is not a sound criterion of the absence of ring rot in a stand of potatoes.

2. *Losses*

It has been stated that the presence of ring rot in a hill of potatoes does not mean a complete loss of marketable potatoes from the plant. In table 4 can be found data showing what reduction might be expected, when the crop contains varying amounts of the disease.

DISCUSSION AND SUMMARY

It can be said that a picker type planter is a very capable instrument in disseminating the bacteria causing ring rot. If seed containing ring rot is planted with such an implement, it can be expected that considerable

TABLE 4.—*Data showing reduction in yield when stand of potatoes containing* 10, 20, 30, 40, 50, 60, 70, 80, 90, *and* 100 *per cent of hills are diseased with ring rot.*

	1945			1946		
Per cent of Hills Infected	No. of Replications	Yield Pounds No. 1 Tubers	Per cent Decrease	No. of Replications	Yield Pounds No. 1 Tubers	Per cent Decrease
0	15	18.1	0	21	18.5	0
10	6	16.2	—10.5	13	17.4	—5.9
20	2	12.2	—32.6	3	18.3	—1.1
30				7	14.9	—19.5
40	3	13.0	—28.2	4	14.4	—22.2
50	1	10.9	—39.8	6	12.6	—31.9
60	6	11.3	—37.6	8	13.5	—27.0
70	4	11.8	—34.8	5	7.9	—57.3
80	5	7.9	—56.3	3	7.9	—57.3
90	2	6.8	—62.4	4	5.4	—70.9
100	4	4.1	—77.3	6	4.2	—77.3

increase of the disease in the crop will result. Under the conditions of the test herein recorded, an assist-feed type of planter did not spread the organism.

The highly infectious nature of the causal organism of ring rot is such that seed containing even a trace of infection should not be used. When it is realized that more than fifty per cent of a crop can become in volved with the disease, when grown from seed which contains but one per cent of infection, it should be apparent to all growers that they should use nothing but completely clean seed.

It has been shown that ring rot may be present in a stand of potatoes despite the lack of aerial symptoms. It would therefore be impossible to estimate adequately the losses in a stand of potatoes based on percentages of hills showing aerial symptoms. Data are offered to show that it does not necessarily follow that the losses in production are in direct proportion to the percentages of the hills involved with the disease. A stand of potatoes involved one hundred per cent is still capable of producing approximately twenty-five per cent of what a stand, devoid of ring rot, will produce.

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THE RELATIONSHIP BETWEEN MATURITY, YIELD, COLOR AND COOKING QUALITY OF EARLY-CROP TRIUMPH POTATOES

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Growers of Triumph potatoes in the Gilcrest district of Colorado have observed that as the tubers mature the color tends to fade. They have also observed that once the vines are dead the tubers lose color, and this influences the length of time the tubers can be left in the soil. Bright red tubers sell more readily and at a somewhat higher price than poorly colored ones.

To obtain some information on the nature of the changes taking place, an exploratory experiment was started in 1946. Five samples of fifty tubers each were taken from as many different locations in a two-row strip through the field on the 25th of July, and on the 5th and 21st of August. At the time these samples were taken, the vines were removed from tubers in the adjacent row, but the tubers were left in the soil. It was planned to harvest the tubers which had had the tops removed on the 21st of August; however, they were not harvested until the 8th of September. By using this technique it was possible to get two sets of data, one giving the color and specific gravity (used as a criterion for cooking quality) at a certain stage of maturity; the other, the color and specific gravity of similar potatoes after they had lain in the soil for various lengths of time after removal of the vines. The results are given in table 1.

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[4]The writers wish to thank Mr. John Greenwalt for his assistance in conducting these tests.

The same kind of experiment was conducted on a different farm in 1947 to determine the changes in yield, color and specific gravity as the plant matures and the change in quality resulting from leaving tubers in the soil without vines. A split plot randomized block arrangement of five replications with 50 hills in each plot was used.

Both years the tops were removed by placing one foot on each side of the stems and pulling them loose from the tubers. This resulted in the removal of the entire stalk without pulling the tubers out of the soil.

Tuber color was determined with the disk colorimeter described by Sparks[1]. Specific gravity was calculated from the relationship of the weight of the tubers in air divided by the difference between the weight of the tubers in air and the weight of the tubers when immersed in water. Both color and specific gravity measurements were made within four days after the tubers were dug. In the meantime, they were stored at approximately 35° to 40° F. In 1946 the statistical comparisons were made by the "T" test, and in 1947 by analysis of variance. In 1947 soil, air and tuber temperatures were taken on a bright, sunny day with thermocouples. The results are shown in table 3. The soil was classified as Gilcrest sand.

Results

In 1946 the specific gravity of tubers with vines attached remained about the same between the 26th of July and the 21st of August as shown in table 1. Similar tubers when left in the soil without vines from the 26th of July until the 8th of September decreased in specific gravity from 1.0690 to 1.0619. The difference is significant at odds exceeding 19:1. Tubers from which the vines were removed the 26th of July were lower in specific gravity than those from which the vines were removed 10 days later, (August 5), by odds exceeding 19:1.

In 1946 tubers attached to green vines decreased in color from 74.7 per cent Eugenia red to 70.3 per cent Eugenia red between the 26th of July and the 21st of August. This difference in color is statistically significant at odds exceeding 99:1. Leaving similar tubers without vines in the soil from the 26th of July until the 8th of September resulted in the color fading from 74.7 per cent Eugenia red to 56.1 per cent Eugenia red, a color difference statistically significant at odds exceeding 19:1. Leaving tubers without vines in the soil from the 5th of August to the 8th of September resulted in the color fading from 70.8 per cent Eugenia red to 57.2 per cent Eugenia red. This color difference is statistically significant at odds exceeding 19:1 as you will note in table 1.

TABLE 1.—*The effect of maturity on color and specific gravity, and the effect of leaving tubers without vines in the soil on color and specific gravity,* 1946.

	Tubers Harvested			Tubers Left in Soil Without Vines[a]	
	July 26	Aug. 5	Aug. 21	July 26	Aug. 5
Condition of vines	Green	Leaves dying	Vine dead	Green	Leaves dying
Mean specific gravity	1.0696	1.0700	1.0698	1.0619	1.0652*
Mean color[b]	74.7	70.8**	70.3**	56.1*	57.2*

[a]Tubers designated as left in the soil were all harvested September 8. Tops were removed on the pre-harvest dates shown

[b]A color rating indicates the per cent Engenia red component, the remainder being light pinkish cinnamon (colors according to Ridgway's Color Standards).

*Significant at odds equal to or exceeding 19:1.

**Significant at odds equal to or exceeding 99:1.

There was no material difference in color between tubers from which the vines were removed on the 26th of July and those from which the vines were removed on the 5th of August (Table 1) when both lots were harvested on the 8th of September.

The 1947 results shown in table 2 indicate the same general trends with respect to color and specific gravity changes in relation to maturity as were found in 1946 for tubers harvested with vines attached.

The effects on color and specific gravity of leaving tubers in the soil without vines were considerably different from those of the 1946 experiment. In 1947 removing the vines and leaving the tubers in the soil failed to bring about color and specific gravity changes of the same magnitude as found in 1946, probably because of different growing conditions between years and between farms. In 1947 the tubers were considerably paler in color at the beginning of the test than they were in 1946. The yield (Table 2) was still increasing when the experiment was terminated on the 9th of August. The yield increase from the 19th to the 26th of July was highly significant; the increase between the 26th of July and the 2nd of August and from this date to the 9th of August did not quite attain significance at the 19:1 level. However, the increase in yield on the 9th of August exceeded that on the 26th of July by odds of 99:1.

DISCUSSION

Changes in tuber color accompanying maturity, though statistically significant, are of doubtful practical importance. A color difference no

TABLE 2.—*The effect of maturity on yield, color and specific gravity, and the effect of leaving tubers without vines in the soil on color and specific gravity*, 1947

								M. S. D.	
Dates tops removed					July 19	July 26	Aug. 2	5 per cent	1 per cent
Dates harvested	July 19	July 26	Aug. 2	Aug. 9	Aug. 9	Aug. 9	Aug. 9	5 per cent	1 per cent
Condition of vines	Green	Green	Leaves dying	Leaves dying	Green	Green	Leaves dying		
Mean yield, in 100 lb. sacks per acre	202	234	241	249				8.6	11.7
Mean specific gravity	1.0730	1.0756	1.0733	1.0713	1.0729	1.0759	1.0743	.0019	.0025
Mean color**	66.2	57.2	59.2	55.7	58.0	56.6	54.7	7.4	10.4

*Tubers designated as left in the soil without vines were all harvested August 9; vines were removed on the pre-harvest dates shown.

**A color rating indicates the percentage of the Eugenia red component, the remainder being light pinkish cinnamon (color according to Ridgway's Color Standards).

TABLE 3.—*Tuber temperature on a bright, sunny day at Gilcrest, Colorado, 1947*

Time	Positions of Thermocouple*							
	1	2	3	4	5	6	7	8
2:05 p. m.	100	102	114	91	93	98	88	89
2:15 p. m.	92	103	112	92	92	98	86	88
2:45 p. m.	102	101	114	95	96	105	93	96
3:00 p. m.	103	101	111	97	95	103	93	95

*1. Air temperature in sun.
2. Air temperature in shade of a box.
3. Soil temperature in sun 1" below surface (soil dry).
4. Soil temperature in sun 1" below surface (soil moist).
5. Underside of a tuber 2" below surface (soil dry).
6. Top side of a tuber 2" below surface (soil dry).
7. Underside of a tuber 2" below surface (soil moist).
8. Top side of a tuber 2" below surface (soil moist).

greater than 10 per cent Eugenia red, though relatively easy to measure on the disc colorimeter, is difficult to detect without the aid of a standard.

However, it 1946 tubers that were left in the soil after the vines were detached lost enough color to make it a practical problem should the vines be removed or killed and the market "go dead" so that the tubers would have to remain in the soil devoid of vines for any length of time.

The specific gravity changes are also of doubtful practical importance. Early potatoes are seldom of good eating quality; and since the cooking quality, as measured by specific gravity, improves but little with maturity and may actually decrease, it appears evident that the proper time to harvest early potatoes should be determined on the basis of yield and market price.

It would appear from the results that "planting early and harvesting late" has little merit. There is but little increase in yield after the vines begin to die, and color as well as cooking quality, as measured by specific gravity, may actually be lost.

A potato tuber represents essentially the amount of carbohydrates not needed by the rest of the plant. Consequently when soil and tuber temperatures are high the rapid rate of respiration must be largely responsible for the low dry matter content of the tubers.

Summary and Conclusion

Yield, color and specific gravity changes in early crop Triumph potatoes were observed throughout the harvest seasons of 1946 and 1947 at Gilcrest, Colorado.

1. Yield in 1947 for tubers with vines continued to increase until the end of the experiment. The rate of increase was rapid at first and then rapidly declined.

2. Cooking quality (as measured by specific gravity) increased until hot weather set in and the tops began to die. Then it decreased slightly, but not to the point of being practically important.

3. Leaving Triumph tubers in the soil after the vines were removed did not materially affect the color or the specific gravity in 1947; however, color reduction of possibly practical importance was observed in 1946.

4. Triumph potatoes fade in color as they mature.

Literature Cited

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SECTIONAL NOTES

INDIANA

The potato situation in Indiana at the present time is very, very quiet. Several carloads of early varieties have been placed on the market and the purchasers have been those with a small acreage, buying as many as one to fifty and sometimes seventy-five sacks of potatoes, whereas the large grower is just marking time waiting to see what is going to happen. It appears that we will grow about 45,000 acres in potatoes this year, a drop from last year, and the growers with a larger acreage in central and northern Indiana will not plant until the end of April and the first part of May, providing the weather is agreeable.

We still find a good demand for potatoes, and judging from the comments I have heard the consumer will go back on a good potato diet if the situation ever clears up.—W. B. WARD

MISSOURI

The potato acreage in Jackson County will be approximately 2,350 acres in 1949. The 1948 acreage was 2,280 acres. Four hundred acres will be planted in the Orrick district (Ray County) where potato production is gradually becoming smaller with growers now planting alfalfa and other farm crops. The total acreage in this section (Jackson and Ray Counties) will be 2,750. Complete fertilizers are being used at planting time at the rate of 500 to 750 pounds per acre. The most popular analysis seems to be 8-8-8 with 10-6-4 the second choice. Most growers expect to side dress during the growing season with ammonium nitrate used at the rate of 200 to 250 pounds to the acre. Cobblers and Red Warbas are the varieties being planted. A few growers are trying a new variety in this section, known as the Dakota Chief. Only small plantings will be made of the Dakota Chief variety this spring.

Potato planting has been delayed and at this time probably not more than one-third of the acreage is in the ground. Excessive rains have kept the growers from our fields. A DDT and copper dust will be used again to control the Colorado potato beetle and various diseases. —BEN F. VANCE

NEBRASKA

The shipping season for Nebraska potatoes is rapidly drawing to a close. Some table stock is still in farm storage, but mostly the poorer

lots. Dealers are finding it difficult to supply their brokers with sufficient supplies of U. S. No. 1's. In some cellars potatoes are sprouting badly. A number of the washer plants will close down this week.

Shipments of certified seed continued to be quite heavy throughout February, and the first week in March. Very little certified seed was moved during the month of January, due to the blizzard which covered the entire seed-producing area. Many growers feared that they would not be able to dispose of their seed. The seed market, however, held up two weeks later than usual, enabling them to dispose of most of their certified seed.

The weather in Nebraska is still more wintry than spring-like. Periods of wet snow or rain occur very frequently. Spring field work is being delayed by the mud. Growers in the central Nebraska commercial area of the state are unable to get into their fields to prepare them for planting. Planting usually commences in this area about the first of April.

Local movement of Foundation seed is taking place in the western late potato area at this time. During the past two weeks, the demand has exceeded the supply available. Growers have shown a great deal of interest in the new red variety, Progress. Only a limited supply of this seed is available, and this was spoken for early in the winter.

It is impossible at this time to estimate what acreage will be planted this year. Planting will not take place in western Nebraska until June. A reduction is proposed, and it seems quite likely that the acreage will be reduced somewhat again this year.—WARREN TRANK

NEW YORK

Our Marketing Agreement Committees are active and before the 1st of May proposed agreement for up-state New York will have been formulated. A series of meetings will be held later to acquaint our growers with the details.

The summer Field Day of the Empire State Potato Club will be held the first week in August, probably in Onondaga County near Syracuse. There is some talk of making this a two-day meeting and various committees are working on the details. We hope to have something definite for the next issue of the Potato Journal.

Certified seed is moving out rapidly despite prevalence of adverse conditions. We believe that as of April 1st the quantity of certified seed potatoes on hand is considerably less than the usual average for this date.

Growers, in general, are cooperating well with the acreage re-

duction program and seem to be quite well pleased with the one price feature. There are no indications that this arrangement will have a surplus, under normal harvesting conditions.

Our supply of table stock is exhausted. Market trends finished strong with prices about 25 cents above support. Shortage of local supplies as well as shortage of cars in Maine have tended to make demand exceed supply.—H. J. EVANS

SOUTH CAROLINA

Potatoes began to emerge the last week of February but frost during the first two weeks of March cut back a large part of the crop. Plantings near the ocean are flowering and are well ahead of schedule, whereas all other plantings are coming along on time. A few growers have reported that Sebagoes have been cut back and are not emerging in normal manner. An occasional plant has been lost, however, but in general the stands are good to excellent.

Although the rainfall has been below normal, weather conditions as a whole have been excellent for the progress of the crop. We anticipate some digging early in May but our general movement will not take place before the 15th.—W. C. BARNES

SUMMARY OF PAPERS PRESENTED AT THE POTATO CONFERENCE HELD AT THE EASTERN REGIONAL RESEARCH LABORATORY[1], OCT. 19-21, 1948

OBJECTIVES OF THE CONFERENCE

Dr. Wells pointed out that the conference was originally planned as a meeting of collaborators from the State Experiment Stations of the 16 Eastern states comprising the area served by the Eastern Regional Research Laboratory. In planning this meeting it was deemed advisable to invite representatives from other interested State Experiment Stations, as well as representatives from other Bureaus of the Department of Agriculture, potato grower organizations, and industry, for the purpose of reviewing and discussing current research on potato utilization in Federal, State, and industrial laboratories. Another object was to consider problems of the potato industry and to determine needed future research in the utilization field.—P. A. WELLS, Director, Eastern Regional Research Laboratory, U.S.D.A., Philadelphia 18, Pa.

[1]This conference was attended by leaders in the potato industry from all sections of the country. The papers presented cover a wide range of subjects of major importance to the industry. For this reason it is considered desirable to reprint the abstracts in this and the next several issues of the Journal.

Potato Outlets

The normal annual crop of potatoes in the United States is about 375 million bushels. A chart was shown which indicated the distribution of the crop for various uses. About 81 per cent (302 million bushels) is used for food, 5 per cent (26 million bushels) for seed, and 14 per cent (53 million bushels) for non-food purposes. Of the 302 million bushels used for food most of it goes for direct consumption (280 million bushels) and about 22 million bushels are consumed as processed food (chips, flour, dehydrated, canned, frozen, and peeled potatoes, and food starch). Manufacture of chips consumes the greatest bulk of processed potatoes (15 to 20 million bushels). About 4 million bushels were used in 1946 for dehydrated food products. About 20 million bushels were used for dehydration in 1943 and 1944 mostly for armed forces. Potato flour (15 to 20 million pounds) requires about 2 million bushels of potatoes. During the past year the production of potato flour was increased many times the normal amount (the goal about 400 million pounds). The flour is being sent to various European countries as a part of the emergency food program.

In the non-food uses livestock feeding is the largest outlet. About 25 million bushels of potatoes (as fresh, ensiled, and dehydrated) are used for this purpose. Starch production (for textile and paper sizes and dextrin, etc.) consumes 10 million bushels. During surplus years (and scarcity of corn) large amounts of potatoes were used for alcohol production (about 30 million bushels in 1946). Some butyl alcohol has been prepared from potatoes. Other potential industrial uses of potatoes were indicated, such as fermentation to lactic acid and other organic acids, acetone, butylene glycol, etc.—R. H. Treadway, Eastern Regional Research Laboratory, U.S.D.A., Philadelphia 18, Pa.

Problems of the Potato Industry

The following may be taken as basic and accurate premises:

(1) That potatoes are grown primarily as a food crop, and for use principally in the fresh form.

(2) That consumers apparently want, and should be given, clean, mature, smooth potatoes, acceptably sized, graded and packaged; and that they turn away from potatoes when these demands are not met.

(3) That sales for manufacture into processed form represent an outlet of lesser importance, though growing each year.

(4) That sales for non-food uses and for livestock feed are a form of safety valve for drawing off, first, the low grades, and then surpluses whenever supply exceeds demand.

(5) That since the average yield per acre in 1948 has reached an all-time high, acreage is the lowest in 67 years, and at the same time per capita consumption is down to an all-time low, production problems are at present less important than problems of distribution and use.

The importance of research in production, however, should not be minimized, and the relation of some distribution problems, such as those of consumer acceptance based on quality, to improvements in production methods should not be ignored. Rather it seems essential to emphasize that production research has been given many times the dollars and man-hours that have as yet gone into studies of marketing, distribution, and utilization.

Conclusion: The number one problem of the potato industry is to check the decline in consumption, which is both a per capita and an over-all decline. From this major problem stem many separate problems; possibly the facts brought out during the Potato Conference will be helpful in finding solutions to many of them.

Probably few in the potato business, including the growers, are completely happy with the government price support program. Originally planned to stimulate wartime food production, it accomplished its objective. It has eliminated the shortages and the black market of 1943, which the public has all too soon forgotten. The public has forgotten, too, that since the potato crop is perishable and has no carry-over, enormous wastes from overproduction have always been a common occurrence. In the days before price support, these losses were borne by the grower, or handler, or both. They caused many a bankruptcy—and nobody benefited.

The price support program has met criticism on two major points. One is based on the feeling that the public supports the program twice: once as taxpayers and again as consumers. The difficulty of finding good potatoes in the retail store also causes criticism.

The foregoing lends background to the concept that better utilization of our crop through applied research may be one of the best and surest means, though not the quickest, of improving the situation and pleasing the consumers.

To check declining demand, the principal problem in the potato field, the Department of Agriculture has begun potato marketing studies among both housewives and institutional users. The results obtained thus far point clearly to the necessity of offering the consumer a better product. The customer wants clean, properly graded, and attractively packaged potatoes. More information is needed on sizes, colors, and

the cooking quality of potatoes for specific uses, such as french frying, mashing or baking.

Probably production control alone can never achieve a satisfactory balance between potato supply and demand. Goals set too low may cause under-supply. It seems safer to *grow enough, then sell the best, and process the rest.* To accomplish this requires the joint efforts of both growers and research men. The industry must find ways, through marketing agreements and other means, of withholding its poorer potatoes from retail sale. The Laboratory must develop new or improved ways of transforming potatoes into useful products. Both the industry and the government, but with emphasis on the former, should attempt to make diversion outlets self-supporting. If this is economically impossible, the cost burden, at least partially, should be distributed over the better portion of the crop and less upon the taxpayer. In the last analysis, research should play an important role in determining future non-food uses of potatoes.—KRIS BEMIS, United Fresh Fruit & Vegetable Association, Washington 9, D. C.

METHODS OF HANDLING POTATO SURPLUSES

The problem of utilizing surplus potatoes was relatively easy before the last war and during the war. In 1934, prices were supported by purchase of potatoes for relief feeding. In 1937, about 6 million bushels of potatoes were diverted to starch and 2 million bushels to livestock feeding. The situation in 1940 was rather similar to that of 1937, with 8 million bushels going into each of the livestock feeding and starch outlets. In 1942, the first year under the Steagall amendment, acreage was reduced and war needs kept the surplus problem at a minimum. A large outlet in dehydrated potatoes for the armed forces and Lend-Lease existed throughout the war.

In 1943. 23.4 million bushels of potatoes were in surplus, of which 7 million bushels were diverted to starch and 9 million bushels to livestock feed. The surplus was slight in 1944, amounting to only 3.6 million bushels. In 1945, the surplus amounted to 23 million bushels, of which 8 million went for export, 6 million to starch, and 3 million to alcohol. The largest surplus to date, 108.5 million bushels, occurred in 1946. Due to the grain shortage, 30 million bushels of potatoes were diverted to alcoholic fermentation during that year; 20 million bushels went into livestock feeding, 11 million bushels were exported, and 9 million bushels went to the starch factories. A record of 34 million bushels of potatoes, however, was lost during 1946 by the necessity of dumping.

The year 1947, with a surplus of 35 million bushels, was characterized by the development of an increased potato flour outlet. The export trade was the greatest outlet, 12 million bushels of the 1947 surplus, with alcohol consuming 7 million bushels, starch consuming 5 million bushels, and flour and direct distribution (school lunches, public institutions, etc.) consuming 4 million bushels each.

The surplus for 1948 is now (Oct. 18, 1948) estimated at 65 to 75 million bushels. Most of the surplus, up to the end of September has gone into ethyl and butyl alcohol. The Government is trying to procure 440 million pounds of potato flour for the Army. During the past 3 months, 50 million pounds of potato flour have been delivered to the Army; this is about 3 times the former annual capacity.

Prospects for future export of potatoes are dim. The flour and alcohol outlets will probably not continue at their present high levels. This leaves only starch and livestock feeding as major outlets. In most of the outlets, the amount which the Government recovers does not equal the costs of freight and storage. The principal objective of research work should be to develop methods of utilizing locally low-grade and surplus potatoes so that no long distance transportation is involved. Field, open-air dehydration may be the answer to this, thus producing a stable form of the potato for industrial use.—A. E. MERCKER, Production and Marketing Administration, U. S. D. A., Washington, D. C.

PROBLEMS IN THE MANUFACTURE AND USES OF POTATO STARCH

The major problem confronting the potato starch industry is the lack of a uniform and continuous supply of potatoes for processing. The human consumption of potatoes is relatively constant and thus small crops bring higher prices than larger crops. Even though acreage remains fairly constant, there is a considerable variation in yield per acre and therefore the size of the crops and the prices received for them vary greatly. An increase of only 2 to 4 per cent above average production often seriously depresses prices.

In years when growing conditions are favorable enough to produce a surplus crop, or market conditions outside the country are unfavorable, or blight hits the crop, the starch factories have ample supplies and profit, and the farmer takes a licking.

In short years the reverse is true. With a constant demand and short supply prices rise. Lower grades find a waiting market at prices higher than industry can pay for potatoes. The lack of sufficient potatoes to supply the Maine factories, where the potential capacity is 25,000 tons of starch, is best illustrated by the following estimated yearly pro-

duction figures. It will be noted that in most cases the yearly production was well below the total productive capacity.

1938	11,000	Tons
1939	9,000	"
1940	17,000	"
1941	15,000	"
1942	12,000	"
1943	24,000	"
1944	20,000	"
1945	12,000	"
1946	22,000	"
1947	17,000	"

Up until the last eight or ten years there was a sharp decline in the number of factories and lack of incentives for modernization due to fluctuation in raw material supply. Since that time the supply of potatoes although lacking anything ideal in its continuity, has been more stable. This is primarily due to diversion of surplus raw material to starch purposes. The results are the extensive modernization of the majority of the existing plants in Maine, the construction of several modern continuous plants and the establishment of a modern potato starch industry in Idaho which produces about 25,000 tons of starch per year.

Still further stabilization of the sources of raw material would attract additional capital in the modernization and replacement of existing plants and it would be an inducement to properly trained personnel to participate in this field.

We feel the primary and most extensive need is an all-out program of education of the importance of our industry in the overall production and marketing of this important agricultural commodity. In Maine, we are becoming slowly cognizant of this fact and have banded together in a non-profit trade organization, The Maine Institute of Potato Starch Manufacturers is to further our efforts in correcting this condition and to solve our many other problems.

Secondly, we feel that closer cooperation between the different segments of industry, such as production and sales with the production, marketing and research divisions of the United States Department of Agriculture could materially further the stabilization of our industry.

Only by combining our research efforts with the efforts of the Bureau of Agricultural and Industrial Chemistry can a far reaching program of development be achieved.

Our basic problems in the uses of starch are mostly confined to efforts in attracting new users. We have a potential production of 50,000 tons of potato starch in the United States and the present users can take between 25,000 and 30,000 tons per year. This leaves about 20,000 tons for new potential uses.

According to Dr. Brautlecht the present uses of potato starch are distributed about as follows:

Textile industry	40 per cent
Foods	20 "
Confectionery	5 "
Paper industry	10 "
Dextrine	15 "
Miscellaneous	10 "

A considerable amount of starch has been exported in the last few years. However, the future of this market is uncertain.

Further utilization by the textile industry will depend largely on improvement in quality of our product, its constant availability and the price relation between it and other competitive starches.

Our largest potential markets are in the paper and food fields. In the paper field, there are today roughly 100,000 tons of corn starch used. Our continued entrance into that field will largely depend on, again, competitive prices of other starches and our ability to furnish stability of both price and supply. This also applies to the food field.

We must endeavor to determine the relative merits of potato starch in comparison to other starches in the various fields.

A standard of grades should be formulated to eliminate confusion on the part of the manufacturer and user. Our Institute has started an investigation of the present grades of potato starch and find that they are almost wholly non-existent. These starch grades as far as practicable should be uniform to the extent that the relative merits of each manufacturer can be compared to other potato starch manufacturers and to other type starches.

Further efforts in research in conjunction with this laboratory in new uses should be continued.

The disposal of potato starch factory wastes will soon require our efforts. For the disposal of potato "pomace" or pulp from the factories, our Institute is now in the process of creating a pilot plant at Mapleton, Maine, with the hope that the process, with the help of this laboratory and the staff of the Extension Service of the University of Maine will be a success. Work has also been done in the ultimate use of this end

product as a livestock feed at the Experiment Station of the University of Maine.

In conclusion I would like to state that the producers and handlers are beginning to stabilize their industry by marketing a superior product. This is exemplified by the acceptance in the various potato areas of marketing agreements. The elimination of lower grades of potatoes from commercial markets can be of great benefit to stabilizing the potato industry. With sound and economical disposal plans an agency should be able to stand on its own feet as a disposal outlet, and be in a position to make the greatest return to the producer of potatoes for his product.—J. H. PAGE, Maine Institute of Potato Starch Manufacturers, Caribou, Maine.

FACTORS INFLUENCING THE QUALITY OF POTATO STARCH

A most important property of all commercial starches is their ability to swell in hot water to form viscous liquids, or pastes. This property is utilized whenever starch is used as a thickening or gelling agent, a coating or sizing material, or an adhesive. Swelling in a limited amount of water is a major reaction when starchy foods are cooked, or dehydrated by heat. Among the commercial starches potato starch swells the most, giving the most viscous and unstable pastes, and is also the most variable.

Potato starch is easily prepared about 100 per cent pure. Its 0.3 per cent of inorganic constituents (ash) should not be regarded as an impurity since they are chemically bound to the starch substance. The ash is often neglected or insufficiently considered, and is the source of much of the reported variability of potato starch. Potato starch differs from the other starches of commerce in that it contains phosphoric acid esterified with the carbohydrate. The phosphoric acid is combined only with the amylopectin fraction—one acid group to approximately 300 glucose units—and it ionizes similarly to ordinary phosphoric acid. In the potato it is about three-fourths converted to the potassium salt. The potassium is readily displaced by other metal ions, with particular ease by the calcium and magnesium of hard water. Potato starch is thus a water softener of low exchange capacity.

The calcium (hard water) starch may be regenerated into the potassium starch by brief soaking in a solution of a potassium salt, followed by washing out excess salt with pure water. The viscosity of the potassium starch pasted in pure water is very much higher than that of the calcium starch. A few parts per million of any electrolyte added before or after pasting reduces the viscosity of the pastes to almost the

same very low value. Paste viscosity shows a sharp maximum at pH 8 even when adjustment of pH is made on cool pastes so that hydrolysis is avoided. The high viscosity of potassium starch pastes is due largely to the enormously swollen granules. These are thin, and when broken by stirring or dissolving in the pasting water, the viscosity drops correspondingly.

Heating potato starch in an excess of water at a relatively low temperature, or in water vapor near 100° C., changes the granule structure so that it becomes much like a cereal starch. Swelling is less, paste viscosity is lower and more stable, and the tackiness and translucency are less.

Small potato starch granules contain slightly more phosphoric acid than do large granules. Correspondingly, the small granules show the higher swelling, when the starch phosphoric acid is combined with sodium or potassium. When combined with calcium, the swelling of granules of all sizes is substantially equal.

Commercial potato starch, stored with the normal 15 per cent moisture at room temperature, shows no detrioration over at least a two-year period. It is still unsettled whether the regenerated starches are similarly stable.

An experiment with Green Mountain potatoes showed that starch quality did not change during storage of the potatoes for periods up to nine months at temperatures of 30°, 42° and 50° F. On storage, the starch loss by respiration or reversion to sugars may be 25 per cent or more. Conceivably this would alter the granule structure of the molecular properties enough to change the swelling power. However, the potassium starch extracted from the stored potatoes using distilled water gave nearly constant paste viscosity for the whole storage period.—G. C. Nutting, Eastern Regional Research Laboratory. U. S. D. A., Philadelphia 18, Pa.

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RESULTS OF SPRAYING AND DUSTING POTATOES FOR LATE BLIGHT[1]

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(Accepted for publication Mar. 15, 1949)

The growing season of 1948 provided ideal epiphytotic conditions for testing fungicides against late blight of potato, *Phytophthora infestans* (Mont.) de Bary. The period was characterized by moderate temperature, high humidity, regular dews, and frequent showers, a combination of factors favorable to the sporulation, germination, and spread of the late blight fungus. The disease was observed on the sprouts and young plants in a small cull pile near Charlottetown on the 3rd of July, this being the earliest recorded date of its appearance in Prince Edward Island. The first field infection was found on the 26th of July, and

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by the 20th of August many unsprayed or inadequately sprayed fields were either dead or rapidly dying.

The variety Green Mountain, as in previous years, was chosen for the testing work because of its suceptibility to attack by late blight, and the plantings were made on the 3rd of June. Each plot was fifty-six feet long and three rows wide—the rows being forty inches apart. Unsprayed plots were alternated with the treated plots in each block of replicates. These plots were included (1) to serve as possible sources of infection, (2) to buffer the treatments, (3) to assure that all plots sprayed with fungicides would bear the same relationship to untreated areas, and (4) to serve as checks.

Seven applications of the fungicides were made beginning on the 19th of July and ending on the 15th of September. The machine was a tractor-sprayer unit, power take-off type, having four nozzles per row, and maintaining a pressure of 275 pounds. 50 W DDT at the rate of 0.75 pounds per 40 Imperial gallons was added to all spray mixtures except C. O. C. S. Niatox and Deecop, which contained this insecticide. The buffer and check plots were treated with DDT on the same days that fungicides were applied. The fungicides listed in table 1 were tested.

TABLE 1.—*Potato late blight fungicides used in screening tests,* 1948

Fungicide	Chemical	Formula
Bordeaux mixture	Cupric sulphate (25 per cent Cu.)—lime	4-2-40
Bordow	Tribasic copper sulphate and magnesium hydrate. 12.75 per cent Cu.	8-40
C. O. C. S. Niatox	Copper oxychloride sulphate 26.5 per cent Cu.	4-40
Deecop	Tetra copper calcium oxychloride 30 per cent Cu.	3-40
Dithane	Disodium ethylene bisdithiocarbamate + zinc sulphate — lime	1 qt. + ½ — ¼—40
Fungicide 629	Zinc nitrodithioacetate	1-40
Parzate	Zinc ethylene bisdithiocarbamate	1-40
Phygon XL	2, 3—dichloro 1, 4—naphthoquinone	1-40
Check	— — —	—

The plots were sprinkled four times during the first two weeks of August with water suspensions of late blight spores. These dissemi-

nations coincided with periods of showers, and a severe epiphytotic was rapidly built up. At first it was feasible to make counts of the lesions on the foliage; but later, when the disease reached serious proportions on the plants of certain treatments, this method of comparing results was abandoned, and it was necessary to employ the less accurate method of estimating the percentage of defoliation. However, by calculating the mean of the estimated defoliation percentages for a treatment it was considered that a satisfactory evaluation of the comparative efficiencies of the fungicides was obtained. The figures obtained on these counts and observations are given in table 2.

TABLE 2.—*Foliage infection—late blight fungicide screening tests,* 1948

Treatment	Lesions per Plant			Percentage Defoliation		
	Aug. 23	Aug. 27	Sept. 3	Sept. 11	Sept. 17	Sept. 23
Bordeaux	0.3	1.8	33.7	39	43	48
Bordow	0.3	2.4	35.9	36	41	48
C. O. C. S. Niatox	0.5	3.6	39.3	38	44	53
Deecop	0.9	7.5	39.2	39	44	57
Dithane	3.3	16.6	31.5	44	52	59
Fungicide 629	8.1	29.9	62.5	71	83	92
Parzate	0.7	4.4	11.4	25	29	37
Phygon XL	1.8	9.5	12.2	13	20	27
Check	N[1]	N	N	89	95	98

1. Numerous

It was noted that the four copper fungicides were of approximately equal value in controlling late blight on the foliage, Bordeaux mixture and Bordow being but slightly superior to C. O. C. S. Niatox and Deecop. Control differences exhibited by the four organic fungicides were great. Plants sprayed with Fungicide 629 were attacked almost as severely as the plants that received no treatment, 92 per cent of the foliage being dead on the 23rd of September compared with 98 per cent in the checks. Plots treated with Dithane showed a defoliation of 59 per cent or more than that recorded for the copper sprays, which ranged from 48 to 57 per cent defoliation. Parzate and Phygon showed outstanding promise under the severe conditions of the experiment, the percentage of defoliation on the 23rd of September being 37 and 27, respectively. Plants sprayed with Phygon XL were still very green when the tests were terminated on the 28th of September, when all plots were killed down by spraying them with a sodium arsenite vine killer. The plants in plots treated with other fungicides showed symptoms of senescence early in September and were quite mature, as indicated by the yellowish-green color of the foliage, before they were

sprayed with the vine killer. From this it would seem that Phygon has a propensity to delay maturity of potato plants.

The plots were harvested on the 8th of October and the tubers were weighed, graded, and examined during the last week of the same month. The results are given in table 3. This table gives further convincing evidence of the ineffectiveness of Fungicide 629. The yield obtained from the plots treated with this material was little greater than that obtained from the check plots, and the loss of 10.2 per cent of the crop from late blight tuber rot was far in excess of that resulting from any other treatment. Plots treated with C. O. C. S. Niatox, Bordow, and Parzate gave the highest yields, more than 290 bushels per acre being recorded for the plots receiving these treatments. Plots sprayed with Bordeaux mixture (4-2-40) produced an intermediate yield of 275.4 bushels per acre, whereas the Dithane, Deecop, and Phygon XL plots fell in the 250 bushel per acre class. In Prince Edward Island Dithane has never shown the excellent results that have been reported from certain other regions, although we have included it in our tests annually since 1945. Bordeaux mixture (4-2-40), which we always include as a standard treatment, has consistently shown superior results with regard to both yield and disease control. The mean yields over the four-year period are: Bordeaux mixture 289.9 bushels per acre, Dithane 275.1 bushels per acre; the mean percentages of loss through late blight tuber rot are: Bordeaux mixture 0.5 per

TABLE 3.—*Yields and tuber infection—late blight fungicide screening tests,* 1948

Treatment	Total Yield in Bushels per Acre	Bushels Marketable[1]	Per cent Loss from Late Blight Tuber Rot
Bordeaux	275.4*	255.0	0.4
Bordow	294.3*	270.8	1.1
C. O. C. S. Niatox	299.1**	276.2	2.3
Deecop	255.1*	235.8	1.3
Dithane	257.6*	231.4	2.6
Fungicide 629	210.4	170.8	10.2
Parzate	290.8*	268.6	1.9
Phygon XL	254.6*	239.9	0 8
Check	199.5	160.6	6.6

[1]Total yield less undersized and rotted tubers.
*Indicates significant difference at 5 per cent level as compared with check.
**Indicates significant difference at 1 per cent level as compared with checks.
Least significant difference at the 5 per cent level = 51.64 bushels per acre; at the 1 per cent level = 94.81 bushels per acre.

cent, and Dithane 3.4 per cent. The low yield of 254.6 bushels per acre obtained from plots treated with Phygon XL is completely out of proportion with its remarkable control of late blight. This fact further suggests that Phygon XL has a tendency to delay maturity and consequently depress the yield of potatoes.

TABLE 4.—*Comparative effects of dusts and sprays on yield and control of blight rot*

Chemical	Method	Total Yield in Bushels per Acre	Bushels Marketable[1]	Per cent Loss from Tuber Rot
Copper sulphate-	Dust	195.5	163.9	5.2
lime	Spray	256.9*	232.1	3.5
Copper oxychloride	Dust	249.1*	215.4	5.5
sulphate	Spray	260.0*	237.0	2.8
Tetra copper cal-	Dust	232.4	196.5	5.6
cium oxychloride	Spray	248.0*	225.9	2.7
Check		167.5	129.1	6.4

[1]Total yield less undersized and rotted tubers.
*Indicates significant difference at 5 per cent level as compared with check plot.
Least significant difference at the 5 per cent level = 72.05 bushels per acre.

In another group of plots dry and wet applications of fungicides were compared. To facilitate the operation of the tractor-drawn duster the plots for this experiment were made larger, each being four rows wide and seventy feet long. The materials employed were: (1) copper sulphate + lime, (2) copper oxychloride sulphate, (3) tetra copper calcium oxychloride. Each of these materials was applied in both dust and spray mixtures, and formulae and rates of application were calculated to give equal copper dosage. Spraying was superior to dusting as indicated by greater yields and by smaller losses from late blight tuber rot (table 4). The sprayed plots produced a mean yield of 255.0 bushels per acre of which 3 per cent was lost from tuber rot, whereas the dusted plots produced a mean yield of 225.7 bushels per acre of which 5.4 per cent was lost from tuber rot.

SUMMARY

1. Four copper and four organic fungicides were tested against late blight of potato in Prince Edward Island during 1948 under severe epiphytotic conditions.

2. Phygon XL gave outstanding control of late blight on the foliage, and in this respect it was followed closely by Parzate. The four copper fungicides, Bordeaux (4-2-40), Bordow, C. O. C. S. Niatox, and Deecop, controlled the disease in the order listed, and were more effective than Dithane. Fungicide 629 gave almost no control.

3. It was evident that Phygon XL delayed the maturity of the plants.

4. All plots treated with fungicides except those treated with Fungicide 629 gave yields significantly higher than the check plots at the 5 per cent level. The yield resulting from the use of C.O.C.S. Niatox was significantly higher than the check plot at the 1 per cent level.

5. Three copper fungicides were applied in both dust and spray form.

6. Spraying was superior to dusting with regard to both yield and disease control.

NEW DEVELOPMENTS IN SEED POTATO CERTIFICATION

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The troubles encountered by certified seed potato growers have shown a wide variation in different parts of the nation. Aside from one or two hazards, usually occurring in each section, because of local environmental factors such as moisture and soil, problems in each community have often varied greatly from year to year. Seed potato growers should be fortified and always ready to expect the unexpected. It is very true that knowledge is gained by each past experience, but it seems impossible to project this into the oncoming season with perfect efficiency.

Most of the difficulties are attributable to the occurrence of old or new diseases. On several occasions, an entirely new disease for a community has developed in epidemic proportions with very little advanced warning. Many such diseases are correlated with weather conditions and insect populations. Luckily ,all of them are seldom rampant during the same season. Some formerly serious diseases have almost disappeared.

For many years previous to 1939, Spindle Tuber was by far the most troublesome virus disease in the North Central States. Since 1940, it has practically disappeared. It is seldom recorded in field readings or southern tests. Several insects are spreaders of Spindle Tuber, but this change is attributed to the advent of a moist cycle which resulted in a reduced grasshopper population. Nature seems responsible for almost eliminating this formerly very troublesome Spindle Tuber dis-

ease. With our present knowledge of grasshopper control, perhaps serious trouble in the future will be avoided.

In 1932, an infrequent and unusual type of affliction was noticed in an occasional certified field. More such plants were noticed in 1935 and Triumph and Cobbler tubers harvested from affected hills showed a large percentage of weak sprouts. In 1937, this disease occurred in epidemic proportions in some of the North Central states. It was given the name Purple Top Wilt. Tubers from Bliss Triumph fields showing 50 per cent Purple Top usually produced about 50 per cent very weak sprouts. Cobbler fields tended to show less disease and tubers still less weak sprouts. A large percentage of the plants in Pontiac fields may have Purple Top, but the tubers seldom produce weak sprouts. For the next few seasons, Purple Top Wilt occurred in varying amounts. Apparently, it was to be a great potential hazard to the seed industry, especially since little was known regarding the cause and control. This disease started occurring in various amounts eastward across the country. Leach attributed the disease to the Aster Yellows Virus being spread by six-spotted leafhoppers. Other workers have been able to accomplish transfer by this insect and by grafting. Conditions during the last three or four seasons have seemed favorable for the recurrence of this disease, including a plentiful supply of the six-spotted leafhoppers, yet its presence has been negligible. Some claim that the use of new insecticides is the controlling factor.

By the time Spindle Tuber ceased to be a troublesome disease and seed certification was getting to be a relatively simple matter in the North Central States, a new disease known as Ring Rot made its appearance. For a few seasons, it appeared as though it would be too high a hurdle for the Certified Seed Industry. Practically all certification agencies bravely set a zero tolerance and, in many instances, managed to keep its seed absolutely free or to commercially satisfactory mere traces. Because commercial potato growers dared not take chances with Ring Rot, they were practically forced to use certified seed and they soon learned that it paid to look for really dependable sources of certified seed. Although the battle with Ring Rot is still intensive, the certified seed industry, through liberal use of disinfectants and diligent effort to avoid all possible sources of contamination, is conquering the situation. Knowledge gained from scientific study has been important. In one or two areas, a surprisingly and unaccountably small amount of Ring Rot was to be found this last season. This causes one to wonder whether or not some unknown inhibiting factor may not be making inroads towards reducing the prevalence of this disease.

Some state certification agencies feel that they have found a way to practically eliminate Mosaic and Leaf Roll viruses. In other states these diseases are just beginning to present a problem. The occurrence and spread of these viruses are closely correlated with the presence of certain aphids. Aphid prevalence is correlated with weather conditions and preditor population. The fact that new insecticides are killing these preditors is presenting a new problem. A few active aphids can result in rapid disease increases. Very few aphicides, some still in the experimental stage may permit much more effective aphid control. Recently, the practice of early vine killing is showing a very marked improvement in control, especially of Leaf Roll.

Potato Scab continues to be one of the most common troublesome diseases. It is probably the biggest single factor in the eliminating and shifting of production areas. Although an enormous amount of study and research has been concentrated on this disease, not a great deal of actual over-all progress in control has been made and it continues with its ravaging and costly progress. In some instances, artificial manipulation of soil reaction has accomplished control. Recently, certain crop rotations, which include rye, are proving beneficial. Varietal resistance is playing an important role and will become more important. Startling results with practical partial soil sterilization may be developed. Hot formaldehyde seed dip is proving the most effective dip.

Marked advances have been made in developing new fungicides for the control of both Early and Late Blight. The use of chemical vine killers and mechanical vine shredders has developed rapidly and helps not only in blight control, but permits early harvest of more mature stock. In many instances, mechanical vine elimination has also made very practical the use of labor-saving mechanical harvesting machines.

Research has greatly helped the potato industry, but has not kept pace with all certified seed producer's problems; hence, in many instances, he has had to surmount them through tiresome and costly effort. The most efficient method for developing good foundation stocks is resulting from careful indexing and tuberline increases. A state is fortunate when it has an area in which foundation stocks can be started and maintained from year to year.

Recently there has been a more widespread use of commercial fertilizer. Higher yields have resulted. In many sections, fertilizer trails have been carried on regularly to discover the best combinations and best methods of application. Where this has been done, one would assume reaching utmost efficiency. New ideas and developments, however, may

[1]North Dakota State Seed Commissioner.

greatly change fertilization practices.

It seems that potato research, including potato breeding work, has just started to gain some real momentum. New varieties will eventually solve many of the present problems. Plant breeders should make much greater effort to eliminate viruses from their new releases. Recent unequal advances in freight rates, improved ways of combating some of the troubles mentioned above, acreage control and price support programs may tend to cause increased production nearer consuming areas, thus affecting present producers of both seed and table potatoes.

As the result of more fertilization, better insecticides and fungicides, larger yields and improved quality are made possible. If better yields and better quality become easier to maintain, a smaller total acreage will be required to supply the table needs of the nation. Less certified seed acreage will accordingly supply the seed market. There will be need for a readjustment of certified acreages. Some relocation of acreage might take place. Even though the growing of good certified seed has been an almost unsurmountable task, the supply has often exceeded the demand with the result of little or no price premium. States might aid greatly in correcting this situation by tightening requirements both in the field and in the final pack.

R. C. HASTINGS, *Seed Commissioner,*
Fargo, North Dakota.

CONVERSION OF POTATOES TO STABLE FORM[1]

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(Accepted for publication Feb. 9, 1949)

The greatest drawbacks to the industrial utilization of potatoes are their great bulk and perishability. The obvious way to overcome these is to convert the potatoes to stable form by drying. Consequently, the Department of Agriculture's Eastern Regional Research Laboratory has been engaged in engineering research on a pilot-plant scale to develop cheap methods of accomplishing this.

[1]Presented at the meeting of the Potato Association of America held in Pittsburgh on November 16, 1948.

[2]Head, Chemical Engineering and Development Division.

[3]One of the Laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.

What is so difficult about drying a potato? Those of you who have tried it on a commercial scale will have some ideas on that point. To begin with, you must evaporate about 4 pounds of water to get 1 pound of dry solids. So you decide to press out some of the water first and save drying costs. Then you find that you have lost nearly 20 per cent of the solids, and your reduced yield may have more than offset your savings in drying. Or perhaps you got into difficulty with the local authorities for putting the press effluents into the river. If your drying was done in a direct-heat drier without precautions to avoid a spark, you may have had a fire or an explosion from the finely divided starch. If you were fortunate enough to avoid these troubles, you no doubt observed that the ground potatoes rolled up into pellets the size of marbles, the insides of which remained soft and doughy even though you dried the outside to a crisp.

Perhaps, instead of grinding the potatoes you decided to slice them and use a direct-heat drier. Then you undoubtedly had the unpleasant experience of having the slices stick to the drier or stick to each other, forming lumps the size of footballs. But you don't want to hear about processes that fail; you want to know about the ones that function.

There are three physical forms in which a potato may be feasibly dried: raw ground, raw sliced, and cooked and mashed. Let us consider first grinding them raw.

Steam Tube Drier Process for Feed

Figure 1 shows a process for producing feed from raw ground potatoes with a steam tube drier. Here the potatoes unloaded from a box car are flushed by flume to a conveyer, which delivers them to a washer. This may be any one of a number of types. The one commonly used in starch factories is simple and efficient. It consists of a semi-cylindrical tank divided into compartments and partially filled with water. A shaft with agitators runs the full length of the tank, and paddles lift the potatoes from one compartment to the next. The clearance between the paddles and the shell is such that the stones are left in the trough and periodically removed with the dirt. The washed potatoes are ground in a hammer mill having ¼-inch holes in the screen. The ground product is delivered to a mixer conveyer, where a sufficient quantity of the dried product to achieve a moisture content not exceeding 45 per cent is incorporated with it. This is equivalent to recycling about 1.1 pounds of dried product for each pound of potatoes ground. This recycling is roughly analogous to refluxing part of the product obtained in fractional distillation.

FEED FROM DRIED WHITE POTATOES

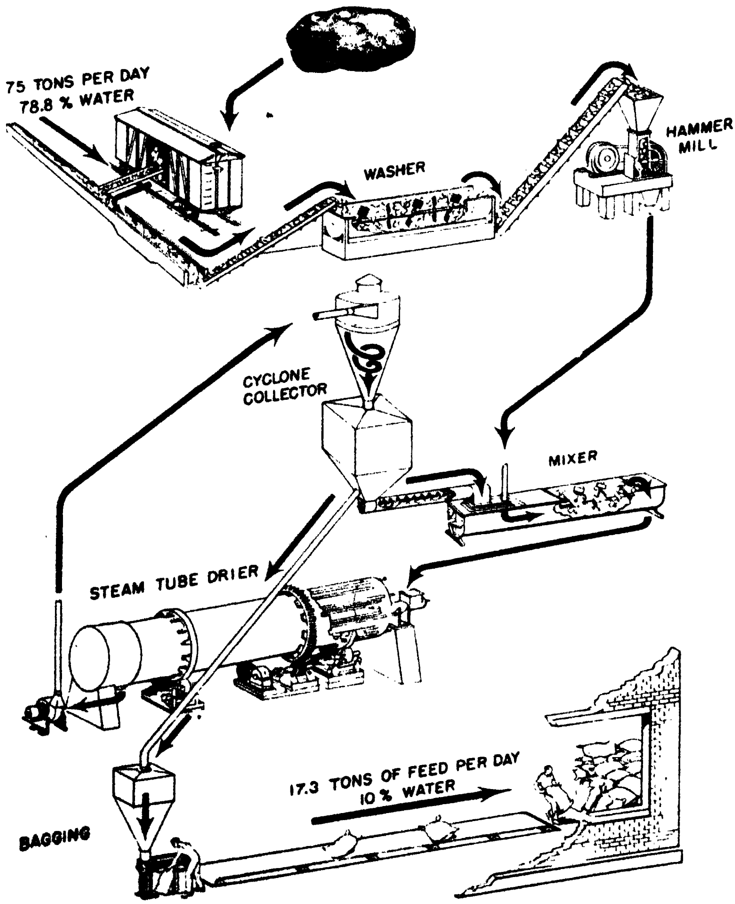

FIGURE I

A thoroughly mixed product below 45 per cent moisture can be fed to a rotary steam tube drier without danger of sticking. Higher moisture contents cause the potatoes to coat the steam tubes, resulting in a mixture of burned and under-dried material. The entire product from

the drier is delivered by a blower through a cyclone to a bin. From the bottom of this bin, the proper proportion of the dried product is sent to the mixer conveyer. The speed of this small conveyer from the bottom of the bin is variable, as is the speed of the belt conveyer going to the hammer mill. The conveyers are adjusted to give the desired 45 per cent in the mixer conveyer. All the dried product not required for recycling automatically overflows from the bin and is bagged. The product is light brown and contains all the protein, minerals and carbohydrates that were in the potato.

Cost

We have estimated that a plant capable of processing 75 tons of potatoes per 24-hour day could be built for an investment of $80,000. Such a factory would produce a little more than 17 tons per day of feed at a cost of slightly more than $24.00 per ton. This figure represents all costs except that of the potatoes and selling costs for the product.

Steam Tube Drier Process for Flour and Meal

Figure 2 shows how this basic method with slight modification can be adapted to the production of potato flour. The differences between this picture and the one you have just seen are (1) an inspection table to eliminate bad potatoes, as the product will be used for food; (2) an agitated tank for sulfur dioxide; and (3) facilities for grinding and screening the dried product to produce flour and meal. The amount of sulfur dioxide required to give between 200 and 500 ppm in the flour is about .075 per cent of the weight of the potatoes. Even this small quantity will cause some corrosion, but this will occur almost entirely in the exhaust duct system from the steam tube drier. For long life this duct should be made of stainless steel.

To insure preservation of the dried food product, its moisture content must not exceed 9 per cent, whereas in feed the moisture content may be as high as 12 per cent. The dried food product will be very light cream in color. It is ground in a hammer mill and screened through a 30-mesh screen superimposed over a 70-mesh screen. The product passing through 70-mesh is flour; that held on the 70-mesh screen and passing through the 30-mesh is meal. The little that remains on the 30-mesh is returned to the hammer mill for regrinding.

Cost

A factory processing 75 tons of potatoes per day into flour or meal by this method would cost about $87,500. It would produce between 16

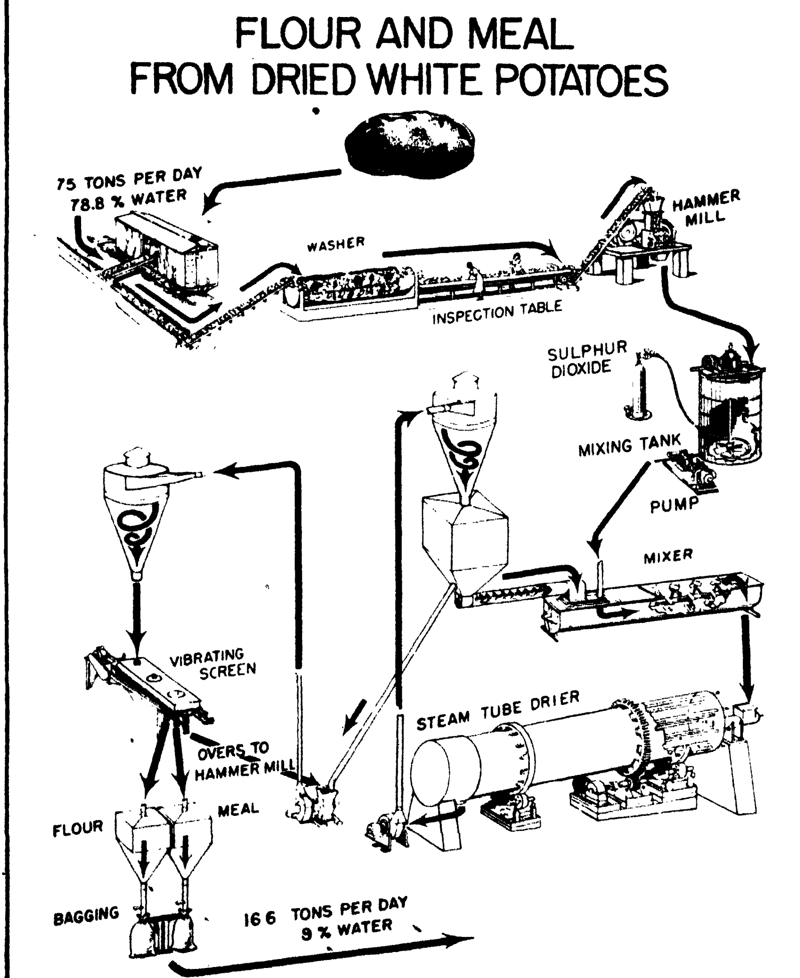

FIGURE 2.

and 17 tons per day, and the over-all cost of the product would be about \$39.00 per ton, including all costs except that of the potatoes and the selling costs. Even if the price of potatoes were included, the cost of making the product would be considerably less than that of the conven-

tional process using cooked potatoes and drum driers. Is the product as good? Its color is only slightly on the cream side, as compared with the standard product, and it is entirely satisfactory for use in dehydrated soups, into which much of the material will go that is required by the Commodity Credit Corporation for European uses. We do not yet know what quality bread it will make, but we suspect it may have different properties from standard potato flour, as it was made from raw potatoes instead of cooked potatoes. We hope later to have more information on this point from the U. S. Bureau of Home Economics and Human Nutrition.

Pressing

At this point one might logically inquire why in these processes for producing feed and food with a steam tube drier, pressing cannot be used to remove some of the water and reduce drying costs. This has been done successfully, and the flour made from pressed potatoes is probably slightly lighter in color than that from unpressed potatoes. However, approximately 20 per cent of the solids are lost by pressing, including nearly 50 per cent of the protein as well as valuable materials and carbohydrates. The press effluent constitutes a disposal problem, and the cost of pressing may be greater than the savings which it achieves.

Figure 3 shows what the process would be if pressing were included. You see a cider press substituted for the recycling device. There is no need to recycle, if the moisture content is reduced to 56 per cent by pressing. With the elimination of some of the sugars and proteins, there is less tendency to stick, and consequently there is no necessity for reducing the moisture content to 45 per cent. Continuous rotary presses cannot be used, as it is not feasible to reach a moisture content of 56 per cent by that means. SO_2 must be used for pressing instead of lime when the product is for food use. The amount required is 0.2 per cent based on the weight of the potatoes. The method depicted here has been used on a commercial scale, and a good product produced, but we estimate that pressing would increase the cost about $2.00 per ton of product.

Direct Heat Driers

We should not leave the discussion of drying ground, raw potatoes without mentioning the possibility of using a high-temperature, direct-heat rotary drier. It is entirely possible to use such a drier when the moisture content of the feed is reduced by pressing or recycling to the point where it will not stick. However, there can be an element of hazard here because of the explosive properties of finely divided starch

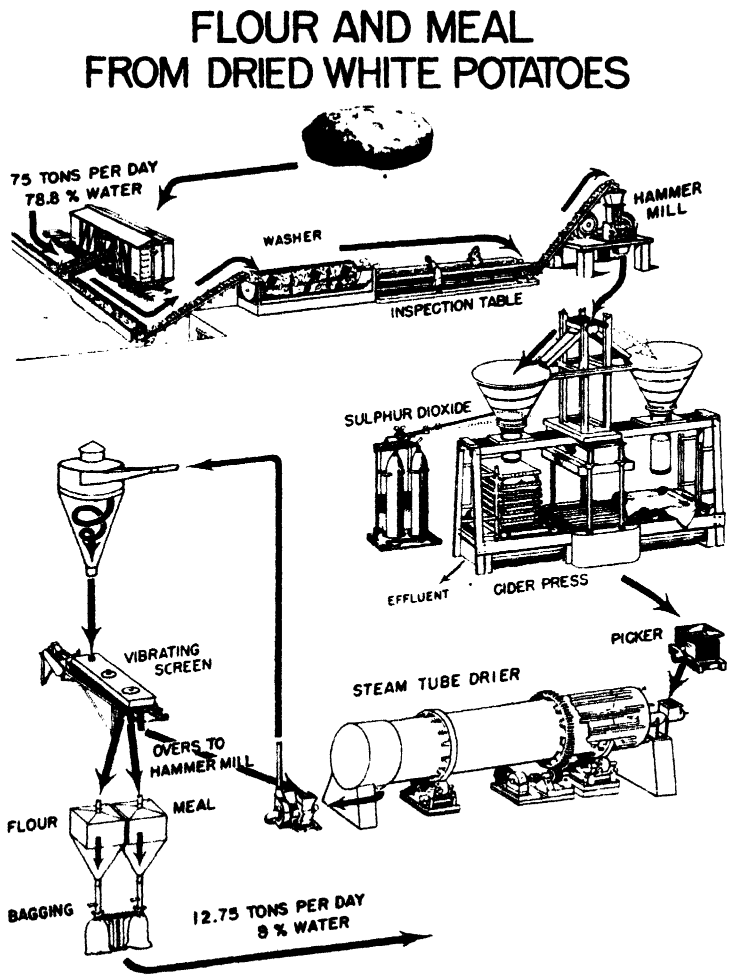

FIGURE 3.

suspended in air. Precautions must ensure that no spark can reach any explosive starch-air mixtures that may exist.

Sliced, Raw Potatoes

We have just mentioned the hazard which can be involved in the direct-heat drying of raw ground potatoes. Why not then cut them into

small, uniform slices to minimize the release of starch and dry them in direct-heat driers? Any one who has tried this will know the difficulties encountered because the potatoes stick to the drier. Even though this may be prevented, the slices tend to case harden and to dry very slowly on the inside. The Germans, however, during the last war, succeeded in drying sliced potatoes in direct-heat beet pulp driers. After soaking, this product was cooked and served to the German Navy. During the survey of European practices for potato utilization we found that they solved the sticking problem by slicing the potatoes uniformly and coating them with ground dried potato. Following this idea and utilizing a drier of domestic manufacture, we have overcome the sticking difficulty and succeeded in drying potato slices. These may be ground to produce feed, or if the color is maintained with sulfur dioxide the product will be satisfactory for certain grades of potato flour.

Cost

We do not yet have enough specific data to make reliable cost estimates on direct heat drying of sliced potatoes, but we believe it will be somewhat higher than that of drying them ground in a steam tube drier.

Cooked Potatoes

The third form in which potatoes may be feasibly dried is after cooking and disintegrating. Last July when the Commodity Credit Corporation invited bids on potato flour in a quantity more than 10 times our normal capacity, the Eastern Regional Research Laboratory was faced with the problem of finding other means whereby existing equipment could be utilized. Figure 4 shows one process developed. It consists merely of adapting double-drum driers of the type commonly used for drying distiller's solubles. Although drum driers are conventionally used for making potato flour, they are of different design. The drums rotate upward and away from each other at their nearest point of contact, and the thickness of the mat on the drum is controlled by superimposed small-diameter rollers. In adapting distillery drum driers, the problem was to deposit uniformly a layer of the cooked potatoes on the drums. In this case, the drums have no superimposed rollers, and they rotate downward and away from each other at their nearest point of contact. The thickness of the layer is determined by the clearance between the rolls.

The solution to the problem proved comparatively simple. If the cooked potatoes, while kept at a temperature about 150° F., are passed through a hammer mill to reduce them to a smooth creamy consistency

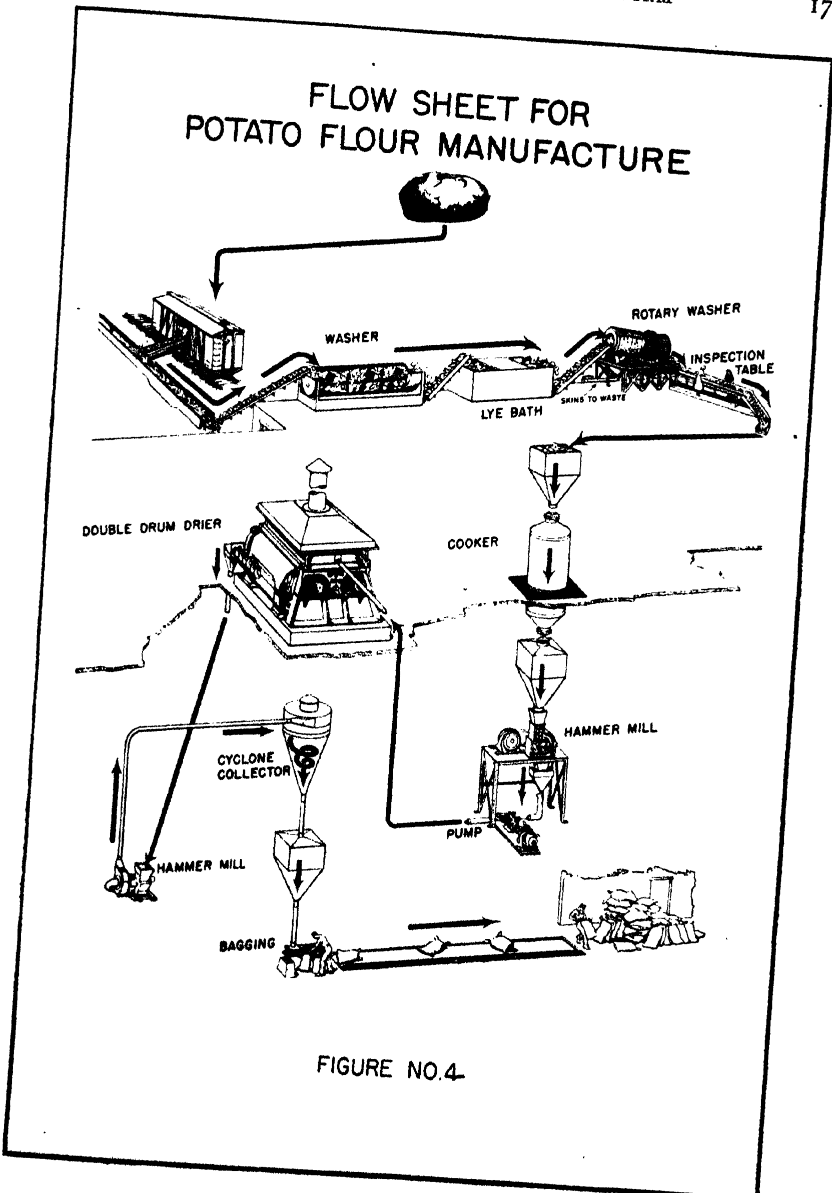

FIGURE NO.4

and, while still hot, are fed to the drum drier, a uniform layer is deposited on the drums.

This principle is being used by large distillers today to meet the emergency demand for potato flour.

Summary

Ground, raw potatoes may be dried with or without pressing in either steam tube driers or direct heat driers, but the former are generally safer. The product can be used for food or with slight modification for certain grades of flour.

Sliced potatoes if coated with a small amount of dried ground potatoes may be dried in direct-heat rotary driers to produce food or certain grades of flour. The process is safe but probably slightly more expensive than drying ground potatoes in steam tube driers.

Finally, drum driers of the type used for distillers, solubles, and other products may be used for making potato flour.

SUMMARY OF PAPERS PRESENTED AT THE POTATO CONFERENCE HELD AT THE EASTERN REGIONAL RESEARCH LABORATORY

(Continued from the April issue)

Disposal and Utilization of Potato Starch Factory Wastes. Mr. Edwards pointed out that wastes from white potato starch factories were of two types (a) protein water containing about 80 per cent of the protein in the potato and consisting of 99 per cent water and 1 per cent solids, and (b) potato pulp consisting of 96 per cent water and 5 per cent solids. These solids usually contain more than 40 per cent starch.

No economical method of recovering the solids from the protein water is known. They are present in too small a quantity. In the case of the pulp, however, the Laboratory has published a recommended procedure based on the Bureau's experience of recovering the pulp from about 2 million pounds of potatoes and on a knowledge of German techniques. The process is as follows:

To the pulp slurry from the factory there is added enough lime to saturate the water associated with the pulp. The mixture is then passed over a dewatering screen and through two rotary presses in series. This reduces the moisture content to approximately 70 per cent. In this condition it can be satisfactorily dried in a steam tube dryer. The dried pulp would analyze about as follows: crude protein 4.81 per cent; crude fat, 0.20; crude fiber, 7.97; and nitrogen-free extract, 72.6 per cent. Based on this composition its selling price might be about $45.00 a ton. The value in Maine, where feed stuffs are at a premium, might be higher.

The capital investment necessary to recover the pulp from a 10-ton per day starch factory would be between $26,000 and $31,500 depending

on the type of dryer employed; *i.e.*, steam tube or direct heat. It was estimated that the cost of production would be less than $45.00 a ton.

Mr. Edwards pointed out the hazard of using a direct heat dryer as the pulp contains about 40 per cent starch and finely divided starch when mixed with air in certain proportions will explode if ignited by a spark. PAUL W. EDWARDS, Eastern Regional Research Laboratory, Philadelphia, Pa.

FERMENTATION PRODUCTS FROM POTATOES. The solids of the potato contain 65 to 75 per cent starch, which can be converted into fermentable sugars which in turn can be fermented into various products, such as ethanol, butanol, butylene glycol, glycerol, lactic acid, citric acid, gluconic acid and others. In the talk production of lactic acid and yeast from potatoes was discussed.

Lactic acid is usually produced from converted starch and various saccharine materials to which inorganic and organic nutrients are added. Dr. Treadway described in detail the production of lactic acid from potatoes without using any additional nutrients. For conversion of starch of the potatoes to fermentable sugars fungal amylases *Aspergillus niger*, NRRL 330 and 337 were used. For lactic acid fermentation several strains of lactobacilli were tested. The best results were obtained with *Lactobacillus pentosus*. Yields of lactic acid varying between 80 and 90 per cent based on the available carbohydrates were obtained. Crude lactic acid can be purified by making methyl lactate and separating the acid from the ester. On the basis of the work done in the Eastern Laboratory one commercial concern made several commercial scale batches of lactic acid from potatoes.

Preliminary results on the propagation of yeast on potatoes were described. The cooked potatoes were hydrolyzed with *Aspergillus niger* NRRL 330. The yeast cells added multiply rapidly and while consuming the sugar present transform the soluble nitrogenous material of the potatoes and the added inorganic nitrogenous substance into insoluble proteins. After 10 hours the number of yeast cells increased 24-fold, and the nitrogen determination showed the presence of 15 per cent insoluble protein (on dry basis). Further work is being done with the view of improving the yield of yeast protein. R. H. TREADWAY, Eastern Regional Research Laboratory, Philadelphia, Pa.

THE MANUFACTURE OF ALCOHOL FROM POTATOES. The use of potatoes as raw material for ethyl or butyl alcohol production in the United States is a relatively recent devlopment. Prior to 1944 such use was negligible. This was not a matter of technology of processing, but was due simply to the inherent economic competitive position of potatoes

as an alcohol source in comparison to other carbohydrate sources which were available at lower cost in adequate amounts.

In Europe, particularly in Germany and Poland, the use of potatoes for ethyl alcohol production has been commercially practicable for perhaps one-half a century and a suitable processing technology has been developed. At least four advantageous factors influenced the European situation—(a) the potatoes usually had higher starch content than the American varieties; (b) the cost of alcohol was a less important consideration since governmental monopolies absorbed the product, constituting virtual subsidies; (c) distinction between alcohol for beverage purposes and industrial purposes did not exist to the extent that is in effect in the United States; and (d) alcohol plants were generally located closer to raw material sources, and were related to the farm economy.

The United States produces more ethyl alcohol than any other country in the world. Sharp distinction is made in this country between alcohol produced for beverage use,—or taxed alcohol,—and alcohol for industrial use, which mostly is tax free. This has had the effect of creating separate alcohol industries,—the beverage (distilled spirits) and the industrial alcohol industries.

In the beverage alcohol field, due to government regulations, only certain specific raw materials may be used for specific products. For example potatoes can serve as a raw material only for the production of vodka, or of special types of liqueurs, which might represent only a very small proportion of the total distilled spirits production. Conversely, there are no legal limitations on raw material for industrial alcohol. However, manufacturing cost imposes selective raw material limitations, because industrial alcohol usually sells at a highly competitive level, ordinarily entailing low profit margins. Historically, the cheapest raw material source has been waste molasses, which formerly accounted for 80 per cent of the total industrial alcohol production. No other available carbohydrate source could compete with it. Even corn, which has 60 per cent starch,—or about five times the amount in potatoes,—was relatively unattractive and represented only 3 to 9 per cent of the actual production.

In recent years the normal economic balances affecting alcohol production have been disturbed. Alcohol sales values have been high, permitting use of raw materials which ordinarily would be uneconomic. Molasses costs have been prohibitively high, grains (until recently) have been rationed and priced virtually out of the alcohol market,—whereas surplus potatoes have been available at times,—at nominal prices. The

industrial alcohol manufacturer is primarily interested in the net cost of a pound of carbohydrate, and the relative ease of handling the material. Hence, when potatoes can fit into the competitive situation, they might be used. Considering the possibilities of future production of synthetic alcohol, or of alcohol from new sources such as wood, sulfite liquor, *etc.*, the possibilities that alcohol production will offer a consistent or significant outlet for surplus potatoes, except under temporary and subsidized conditions is not good. This statement is predicated on *normal* demand, and would be modified if emergency needs for alcohol arose.

Future possibilities of significant expansion of alcohol markets seemingly lies in the fields of synthetic rubber and motor fuel—and synthetic rubber needs are questionable under normal peacetime conditions. As a conceivable possibility, rubber production for peacetime use might represent outlet for 65,000,000 gallons for 100,000 long tons of rubber. However, production of synthetic alcohol may be upwards of 100 million gallons annually in the future, in contrast to the 25 million prewar rate. Considering also the further inroads on alcohol markets being made by direct production of ethyl-derivate chemicals from natural gas, petroleum, and acetylene, plus the competition now developing from methyl and isopropyl alcohols, it can be seen that fermentation alcohol markets are shrinking, rather than expanding. The only exception that can be foreseen is in the possible future use of alcohol motor fuels. Such outlets might be expanded to an amount many times greater than the present total alcohol production. Use of alcohol raw materials, and trends of uses were shown.

Potatoes can be processed for alcohol production without unusual difficulty, except for preliminary handling aspects, and yields are proportional to carbohydrate content. The alcohol can be refined to a quality comparable with alcohol from any other source. There has been some difference between European and American processing methods. In Europe, most production has come from very small distilleries, of farm type. Comparable production units do not exist in the United States. In Europe the steam explosion or Henze method of cooking was largely used, whereas most American plants resorted to the simpler and more rapid method of hammer milling the raw potatoes to a slurry which could be easily handled. However, about a dozen American plants have been equipped to use steam explosion methods. Except for the difference in cooking procedure, the potato fermentation operation is comparable to that used with other raw materials, although by-product feed recoveries are only about one-fourth that from grain.

The yield of alcohol from dried potato slices is about the same as that obtained from an equal weight of corn.

The author concludes: "It may be inferred, that future use of potatoes for ethyl alcohol production, in significant amounts, is likely to be related to comparative economic conditions or on induced use by socio-political expedients.

"There is at least one manufacturer using large quantities of potatoes for production of butyl alcohol. Butyl alcohol markets are more limited than ethyl, and there are only about 5 manufacturers. The same conclusions will stand as for ethyl alcohol." P. BURKE JACOBS, Northern Regional Research Laboratory, Peoria, Ill.

SUN-DRYING OF POTATOES IN SOUTHERN CALIFORNIA. Potatoes were sun-dried in Kern County, California, on a large scale for the first time in 1944. Over 30,000 tons of surplus potatoes were dried in that year on a desert strip 2½ miles long and ½ mile wide. The first contract price was $29.50 per ton to dehydrate the potatoes including land rental, clearing the debris, dumping and spreading the potatoes, puncturing and turning the potatoes, windrowing, picking up and grinding to a meal, purchase of sacks and labor of packaging, and hauling to a central depot.

In the initial operations the potatoes were spread by hand, up to a depth of 4" to 6". Tractors and other mechanical equipment were later used in spreading. Difficulties were encountered in stirring the potatoes during drying. The combination of horse and hay rake was tried for stirring, followed by a "Kansas weeder", the prongs of which stirred the potatoes. Windrowing aided the picking up of the potatoes after dehydration. Removal of dirt constituted quite a problem. The dirt and the petrification caused much abrasion in the hammer mills during grinding to meal and the dirt resulted in ash contents up to 17 per cent.

The potato meal was mixed 1:1 with barley and 1:1 with dried orange pulp for feeding. Feeders discount potato meal approximately 10 per cent or more under the price of barley. At present, a processor can pay only about $2.00 a ton for raw potatoes to be sun dried in order to insure a reasonable profit.

There was no potato surplus in Kern County in 1945 and no sun drying operations were conducted.

In 1946, on account of the large potato surplus and grain shortage, 300,000 tons of potatoes were sun dried. The potatoes were spread on runways and strips of abandoned airfields. Improvements were made in handling the potatoes by use of "bulldozers" and other large equipment such as steam rollers, road graders, etc. Blowers were used to separate the potato meal from crushed rock and to transfer the meal to railroad cars. The 1946 production went mainly into alcohol production.

The 1947 table stock market was strong and only enough potatoes went into sun drying to produce 8,000-10,000 tons of meal. Further improvements were made in breaking up the potatoes; this time rubber-treaded "half tractors" were employed. This equipment did not break up the asphalt runways but still punctured the potatoes satisfactorily. Also a combine was developed to windrow, pick-up, grind and sack the meal as it moved down the field.

During the summer of 1948 unusual difficulties were encountered in that the weather was too cool for effective sun drying. Flies were attracted to the potatoes, and it was necessary to spray the surrounding areas to kill them. HARRY AMENTA, International Fertilizer and Feed Co., Bakersfield, Cal.

FREEZING-DEHYDRATION OF POTATOES IN NORTH DAKOTA. In his introduction, Dr. Wells pointed out that the Red River Valley of North Dakota is really an immense freeze dryer in winter with temperatures as low as 40° below zero.

Formerly Mr. Case had felt that the potato problem would be solved if uses could be found for those potatoes which shouldn't go to market and he still thinks this is true. Out of the 30,000 cars of potatoes grown in the valley, a considerable number normally are fed directly to cattle, hogs and sheep. Objections to direct feeding are the high water content, the inclement weather during the marketing season and the feeders' objections to feeding fresh potatoes.

The talk was based on observations, the first of which was that potatoes spread on the land in the winter and frozen, did not rot during the spring thaw. It was discovered later that the natives in the Andes Mountains had been freeze drying potatoes for a long time. The potatoes do not have to go through freezing and thawing cycles, they will dehydrate if frozen solid only once and thawed out the next day. The potatoes dry suprisingly rapidly and can be spread at any time during the winter. Because of high labor costs, culls should be gotten rid of as early as possible. The ideal situation would be for every farmer or at least every warehouseman to handle his own culls so as to avoid transportation costs. The cattle pick up the potatoes off the pastures and eat them, with no labor costs involved. Feeder cattle pass through the Red River Valley on the way east to market. The packing houses even pay a premium for potato-fed beef.

The carrying capacity of pastures is about double by spreading potatoes on them. Grain yields have been doubled in the same way. Potatoes picked up in May were found to have 82 per cent solids, 71 per cent starch and 0.15 per cent sugar. Machinery might be used to pick

up the potatoes if they were spread on a hard surface. The mummified dried potatoes do not seem to be damaged by heavy rains.

Few exact data are known at present but systematic studies are under way at the North Dakota Agricultural College and the University of Minnesota.

Mr. Case also mentioned the silo method of drying. Early experiments indicate that fermented potatoes lose water readily and thus are more easily dehydrated than untreated potatoes. Apparently the cell walls are ruptured.

This season, 300-400 carloads of potatoes will be spread out on the prairie to freeze dry. Feeders outside the valley are buying up potatoes. W. M. CASE, Red River Valley Potato Growers' Association, Grand Forks, N. D.

USE OF ENSILED AND DEHYDRATED POTATOES IN LIVESTOCK FEEDING. Potatoes have been fed to animals and poultry for many years. A technical report appeared on this subject as early as 1890. Potatoes on the dry basis may be compared with white corn in feed value. Carbohydrate and protein contents are about the same, and neither contains carotene. Potatoes are lower in phosphorus than corn. A protein supplement is generally required when either potatoes or corn is fed.

Potatoes dehydrated by many different processes have been used in feeding practically all types of livestock. Swine digest potatoes best of all animals, assimilating 90 per cent of the organic matter. Cattle, sheep and horses digest potatoes well. Variable results have been obtained with poultry, the dehydration procedure affecting the digestibility. From 10-30 per cent of a grain mash may be replaced with dehydrated potatoes for poultry feeding. Fifty per cent of the grain used in feeding swine can be satisfactorily replaced with dehydrated potatoes. Experiments are being initiated in duck feeding, in which it is hoped to replace upwards to 50 per cent of the grain with dehydrated potatoes.

The Bureau of Dairy Industry has conducted research on methods of making potato silage and tests on its feeding to dairy cows. When ensilage is produced from raw potatoes, it is best to add grain or preferably hay to reduce seepage losses. If 15-22 per cent of hay is added to the potatoes as they are chopped in an ensilage cutter, excessive loss of nutrients due to seepage is eliminated. The cows made good weight gains on potato silage and maintained their milk production. It appears the potatoes fed in moderate amounts after milking do not affect the odor or flavor of milk. The quantity of raw, chopped potatoes or potato silage fed should not be more than about 4 pounds daily per 100 pounds live weight.

A study of cooked potatoes silage and its feeding was recently made by the Bureau of Animal Industry. The potatoes were steamed and placed in experimental silos at approximately 35°, 63°, and 85°F. The 63° temperature was found best in that it was high enough to promote fermentation and inhibit putrefaction but not high enough to cause undue loss of nutrients. About 25 per cent of the carbohydrate was lost during one year's ensiling at the intermediate temperature. N. R. ELLIS, Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

ENSILED POTATOES AND THEIR FEELING. The method used for ensiling the potatoes was of German origin and has been described by Karl Brandt, Economist, Food Research Institute, Stanford University, California. To be economic, the potatoes must be obtainable at little or no cost, under 20 cents per hundred weight. Approximately one-third of the solids are lost during the ensiling period as it was carried out.

The potatoes were cooked with steam in the truck bodies under canvas for 45 minutes before dumping into trenches. Drainage was provided at the bottom of the trench. After being packed in, the potatoes were covered with about 3 feet of pea vines. The loss in weight during fermentation was about 15 per cent and the volume shrinkage was about 20-22 per cent. The drainage liquor contained 1.6 per cent protein, 1 ash and 7.8 per cent total solids. Small scale tests show that the leaching loss largely can be prevented by mixing 25 pounds of chopped alfalfa hay with every 400 pounds of cooked potatoes.

The potatoes were fed to hogs after 60-90 days in the trenches. About 5 pounds of silage supplemented by 2 pounds of a mixed barley-alfalfa ration were fed per 100 pound hog per day. It was estimated that 300 pounds of feed solids made a 100 pound net gain.

The pre-war potato economy was much better balanced in Germany than in the United States. Buffer outlets are needed here to prevent the sharp price changes occurring. A 10 per cent surplus will cause a drop in price of 40 to 50 per cent. In the United States the per capita consumption is only 2.5 bushels while in pre-war Germany it was 30 bushels of which 9 bushels were used as human food. A means of taking care of the surplus which occurs in good crop years is badly needed. Probably this can be done as at present or by price support by an industry-wide agreement, possibly by a per sack levy on marketable potatoes, or by a combination of a support price, not necessarily 90 per cent of parity, and industrial utilization. As we have less and less expendable natural resources, we will have to have an intensive stable agricultural economy coupled to vast industries for converting our crops to needed materials.

Potatoes will contribute a large share toward an adequate national economy. H. G. ZUCKERMAN, Weyl-Zuckerman and Company, 501 Bank of America Building, Berkeley 4, Cal.

PROBLEMS IN THE PRODUCTION AND STORAGE OF POTATOES FOR FOOD USE. In spite of a declining per capita consumption, the consuming public is becoming more critical in its choice of potatoes. Probably potatoes will have to be separated into different classes according to uses. At present, the main part of the annual production is sold just as potatoes although about 20 million bushels of selected varieties were used the past season for chipping. Although certain varieties have outstanding characteristics, these vary when the potatoes are grown in different localities. For example, the starch content of Katahdins varied from 10 to 15 per cent when grown in different localities.

Great care is needed in handling potatoes at every step on the way from the field to the kitchen. Minor injuries tend to develop into major injuries later. Around 50 per cent of the potatoes are often injured during harvesting and storing. Washing tends to increase the extent of injury, especially that due to decay organisms. Attempts to combat this are being made by chlorinating the wash water, by drying the potatoes immediately and by use of refrigeration.

Potato diseases often cause considerable loss. Bacterial soft rot in early potatoes often enters through cuts and bruises, especially if the potatoes are exposed too long to hot sun. Vines should be dead about 10 days before digging where late blight is prevalent to prevent its spread; rapid cooling and low temperature storage, 40°F., also help. Stem end browning should properly designate only that of non-parasitic origin. Fusarium infection and vine killing operations cause similar effects. Net necrosis is caused by leaf roll virus. Freezing necrosis is similar. Greying of the flesh after boiling or baking and a browning during deep fat frying or dehydration are disorders about which not much is known.

Storage temperature is very important. In general 40-50°F. is the most satisfactory, 50° for short storage periods. Sprouts grow very slowly in this range. Potatoes from 40° storage should usually be conditioned before use. Sugar develops in low temperature storage and may be decreased by holding the potatoes at 60 to 80° F. for a period.

Sprout inhibitors may be used successfully if the directions for use are followed closely. No change in flavor or quality was detected after the use of two commercial sprout inhibitors. Storage at 50°F. or above may cut down the loss in ascorbic acid. Shell bins cut down shrinkage in storage. These bins have air tight walls and the air circulates around rather than through them. R. C. WRIGHT, Bureau of Plant Industry,

and Agricultural Engineering, United States Department of Agriculture, Washington, D. C.

"A" THE POTATO PROGRAM OF THE WESTERN REGIONAL RESEARCH LABORATORY. Four phases of potato work at the WRRL were discussed.

1. *Potato Dehydration*: Results of investigations at the Western Regional Research Laboratory on dehydration have been published in the U.S.D.A. Miscellaneous Publication No. 540, Vegetable and Fruit Dehydration, and in several technical articles.

These investigations showed: (a) The type of potato which becomes white and mealy when cooked is preferred for dehydration. (b) Overblanching of high-density potatoes resulted in a product having a hard shell and a hollow center which caused mushiness in the reconstituted product. (c) Underblanching caused darkening during processing and hastened deterioration during storage. (d) Sufficient sulfite to produce a dehydrated product containing between 400 and 500 ppm. of sulfite markedly improves the color and increases Vitamin C retention and improves storage quality. (e) Data were secured to determine the effects on drying time of such variables as air temperature, humidity and velocity; size and shape of the cut pieces of potato; and the density of loading on the drying tray or conveyer.

2. *Deterioration of Dried Potatoes*: Storage tests have emphasized the effect of high temperature in hastening deterioration of dehydrated vegetables. Sulfiting, inert gas packaging, low-temperature storage and in-package desiccation have been investigated. The use of in-package desiccation extends the storage life of dehydrated potatoes at room temperature about six-fold. As one phase of the study of deterioration of dried potatoes during storage, a method has been developed of measuring the amount of discoloration by solution of the pigment formed and photometrically measuring the intensity of the color.

3. *Composition of Potatoes as Related to Specific Gravity and Quality*: Potatoes at the extremes of density range are unsuited for commercial usage. Low density potatoes are watery and waxy and produce a translucent product of poor reconstitution properties, while potatoes of very high density often result in products which slough badly on cooking or have low cohesive properties. The causes of these peculiarities are obscure.

4. *Potato Utilization for Food*: The major emphasis of our present research is placed upon the development of new food uses for potatoes. This is a logical means of counterbalancing the decline in consumption.

A successful commodity must fulfill one or several of the following objectives:

1. Provide a more economical method of using potatoes.
2. Provide a cheaper, easier or less time-consuming method of utilization.
3. Offer a better or at least equal quality product.
4. Provide a new appetite or taste appeal.
5. Provide an acceptable and economical substitute for a similar product from another source (potato flakes *vs.* corn flakes).

Prepared potatoes for hotel and restaurant trade (that is, either peeled or sliced for French fries) offer several advantages. The industry of preparing and marketing such potatoes is already well established in a number of large cities.

We are investigating methods of preserving peeled potatoes.

Frozen prepared potatoes and dehydrofrozen potato slices for French fries appear to offer much promise of an industrial method of preparing potatoes for wider consumer use.

Dried potato products are relatively stable; they offer a large variety of possible food uses; and their cost of processing, storage and shipping is low.

The preparation of potato chips from dehydrated potato slices is entirely possible and offers many advantages, such as stable quality, ease of handling, savings in weight, storage space and refrigeration.

We have produced a potato crunchy or puff by dehydrating potato cubes at a sufficiently high temperature to case harden the exterior and produce a pressure in the interior which puffs out the cube as it dries.

A list of 20 uses for potatoes in food products was given. FRANCIS P. GRIFFITHS, Western Regional Research Laboratory, Albany, Cal.

SECTIONAL NOTES

ALABAMA

In spite of many close calls and worry Alabama is harvesting a better than average commercial potato crop. We ran close calls with frost in March, early blight and some lack of moisture during the latter part of March, excessive rains in April, and the worst blight condition in five years during the latter part of April until the present time. We have had few fields where yield was materially reduced by blight but as a general rule most of the fields were held up by a quick application of copper or Dithane, or Parzate in dust or spray forms. We started shipment earlier to take out fields that were down with late blight and with our set-up all the farmers started digging thus sending too many green potatoes to market in poor shape. Nature aided us by

giving a week to ten days when it was impossible to get in the fields and now it is the belief that most of the crop will ship in good shape. To give us another extreme condition the 6th of May was supposed to have been one of the hottest days on record in Mobile according to the weatherman's prediction.

Our approximately 15,000 acres of early commercial potatoes should yield better than 4,000 cars and today the price is $2.60 for No. 1 Reds (Triumphs) and $2.75 Whites (Sebago) cash to the grower at the shed. Most of our fields will yield nearly 100 bags per acre and at this price our farmers should make some money. The Government has not had to buy many B and cull potatoes as yet. Our dealers think that perhaps the market outlook is better than normal for the balance of the season.

We think we have learned that Late Blight can be commercially controlled by either dust or spray even under very severe conditions in Alabama. The most important factor in control seems to start a regular program early and just apply weekly applications if possible.

It seems now that Alabama should be happy about our potato crop. —FRANK E. GARRETT.

INDIANA

We have considerable acreage planted to early maturing varieties, and the later maturing varieties will be planted within the next week to ten days for most localities in the state. The southern area, however, will delay planting until the latter part of May. Apparently our growers are planting a little earlier each year in order to escape some of the summer drought and also to prevent, if possible, the attack of any late blight. Our growers are well equipped with spraying and dusting equipment and each year we find that more and more of them are putting in overhead irrigation, using portable pipe. We will maintain about the same acreage as we have the past four or five years which no doubt will keep us in the home-consuming state rather than for any potatoes for export. Things are very quiet concerning marketing agreement.—W. B. WARD.

MICHIGAN

As a result of climatic conditions this spring our crops are advanced two weeks. Generally, throughout the state we had below normal snowfall last winter, followed by deficient rainfall in April.

Some early planting has started, but most of the early areas will plant during the first half of May and the late areas which comprise the largest

part of our acreage will be planted the last half of May and early part of June.

The acreage planted to potatoes in the state this year will probably be 10 per cent below last year's acreage.

Our table stock is about cleaned up. The Government shipments were higher this year than they have been at any time during the support program.

Michigan's operated under the marketing agreement which prohibits the movement of B's and two's. This has materially helped our marketing program by the removal of this low grade from commercial channels.

Certified seed acreage indications are far above our normal planting. This past season has been quite pleasing to the seed growers. Our shipment went out early, with only an occasional car still to be shipped.

Indications are that the acreage entered for certification this year will show some shift in varieties, declining in Russet Rurals and increasing in Katahdins.

Of interest to many of the members of the American Potato Association is that E. J. Wheeler, Plant Breeder of the Michigan State College, has just returned from a year's stay in Japan with the U. S. Army where he assisted in a potato production program there.—H. A. REILEY.

NEBRASKA

Shipments of Nebraska potatoes terminated, for the most part, about the 15th of April. The volume was somewhat higher than last year, with both table and Certified seed. On the basis of grade, the quality was not so good as last year. Fewer cars of No. 1's and a great many more cars of No. 2's were shipped on the table market this season.

Planting operations in the central Nebraska area are almost complete at this time. Considerable rain and two late spring snow storms have delayed growers in this area from two to three weeks. To date, we have no report on acreage planted in this area.

In the western late potato section of Nebraska, planting will not begin until the first week in June. At present, growers are working over their seed potatoes and treating them in hot formaldehyde. Favorable weather has enabled farmers to carry on their field work ahead of schedule. All small grain crops are in excellent condition.

Only a small part of the late potato crop in western Nebraska was diverted to the Government under the past season's price support program. Most growers were able to sell their potatoes through local shippers at comparable prices. Growers in western Nebraska are pleased

with certain aspects of the Government potato support program for 1949, particularly payments based on a No. 2 minimum. They are quite concerned about the reduced acreage allotments. Some are complying, others are not signing up because they do not wish to reduce their acreage to the extent for which the allotment calls.

At this time records are being completed and the books closed for the fiscal year in certification work. District and annual meetings of the Nebraska Certified Potato Growers are being held. Applications for certification in 1949 are just beginning to come in. It is estimated that the Certified acreage in Nebraska will be about the same as last year.—WARREN TRANK

NEW JERSEY

Most of our potato crop was planted under favorable conditions. Nearly all plantings have emerged so that a very good stand is evident in the majority of our fields.

Considerable fusarium dry rot was found in some lots of seed when it was cut, and seed piece decay was observed on a few farms both before and after planting. Our growers have again been urged not only to treat their seed but to handle it in a manner that will allow a good layer of corky tissue to form on the cut surface. These precautions, if followed, will reduce losses from fusarium seed piece decay.

The potato acreage has been greatly reduced since most growers are complying with the reduced acreage goals. The Crop Reporting Board of the Bureau of Agricultural Economics estimates this cut to be 24 per cent below the 1948 planted acreage. This is the greatest reduction listed by any state. In order to increase yields per acre many growers have spaced their potatoes closer in the row than in former years and some are planning to side-dress their potatoes with more fertilizer during the growing season.

The Annual Summer Meeting of the New Jersey State Potato Association has been tentatively arranged for June 14 at 1:30 p.m. at Clifford and Richard Ely's farms located 2 miles east of Hightstown on the Hightstown-Freehold Road.—JOHN C. CAMPBELL.

OREGON

Klamath District was part of the marketing agreement area embracing all of central Oregon, and the Klamath Basin in Klamath County, Oregon and Modoc and Siskiyou Counties in California operated under a marketing agreement in 1948. The cull regulation and two-inch minimum regulation were in effect. The general feeling here is that this type of regulation is satisfactory and was instrumental in keeping

undersized potatoes off the market. There is a lot of discussion on proposed potato support programs. The yields and the quality of the 1948 crop were the best on record. Although some credit for this condition belongs to a favorable season, undoubtedly the potato disease and improvement program carried on here is giving very fine results.

Good seed, preferably foundation or certified, combined with roguing and disease control seems to be particularly effective. It looks now as if 16,500 acres grown in 1948 will result in the shipping out of over 11,000 cars, a district record. The acreage in 1949 will be about the same as 1948, and more than 90 per cent of the acreage should be in compliance.—C. A. HENDERSON

SOUTH CAROLINA

The potato crop is now within two weeks of harvest and it promises to be one of the best on record. Until late blight was reported yesterday no disease problems had arisen and rainfall had been adequate for good growth. The movement will begin on the 16th of May with a few early crops being moved the preceding week. This is about the time for movement to become general, perhaps a week earlier than many crops. The use of copper-DDT dusts and sprays have been consistent and unless the weather changes radically no great damage from blight is anticipated. If summer showers should become general, and temperatures remain low, blight could still do a lot of damage to the crop.

Attention has turned from growing to getting the washers into operation and arranging for vine killers. A large portion for the crop will be washed Sebagoes and the use of vine killers has become a fairly general practice in the more important production areas.

Every one is hoping for a good market and at this time the prospects are fairly promising.—W. C. BARNES

WASHINGTON

I cannot give you very much news about the potato industry in this state at the present time. Indications are that somewhat more than the allotted acreage will be planted. Quite a few potatoes are going in on land recently brought under cultivation in the Columbia Basin project. Few if any of these growers have allotments. They seem to feel that they will be able to market their crop. The season so far is somewhat early and quite dry. In the Moses Lake area and the Yakima area the growers are sticking pretty closely to their allotted acreages. Outside of these two areas, there is some over-planting.

The farmers with whom I have talked seem to approve of marketing agreements and Federal regulations generally. They apparently believe

that while regulation is not without some aggravations it is better than the old style free competitive farming which seems to be a thing of the past.—M. R. Harris

Canada

The export sales of certified seed potatoes in Canada from the 1948 crop have been the highest on record. Both table and seed potatoes are in short supply in many of the provinces. The holdings in Prince Edward Island and New Brunswick are fairly low indicating that the movement has been very satisfactory. Under the price support program handled by the Dominion Department of Agriculture, potatoes will be bought by the Dominion Government as of the 1st of April at $1.25 per cwt. on the farm, on the Canada No. 1 basis, in the provinces of Prince Edward Island and the larger producing areas in New Brunswick. The weather has been extremely dry in the prairie provinces and the prospects are not too bright although very little planting has been done as yet. In other parts of Canada, conditions are somewhat better and the indications are that in Quebec there will be a larger acreage planted than that in 1947.—J. W. Scannell

Province of Ontario

Practically all supplies from concentrated potato-producing areas have now been marketed. In other areas where regular marketing practices have been established, small quantities remain on many farms. Large quantities continue to arrive from the Maritimes, with often each day from 30 to 40 cars on track for the Toronto market alone. Markets continue firm at Support Price levels, which for Toronto, wholesale to retail, bring $1.65 to $1.70 per 75 lb. bag; with 15 lb. pre-packaged 37 to 39 cents; and 10 lbs., 26 to 28 cents. There has been an excellent demand for seed with 49 carloads being exported from one area.

Planting of the early crop is about complete with plants showing above the ground in the first planted fields. The foremost subject uppermost in the minds of many late potato growers is the establishment of central facilities for grading and warehousing in principle potato areas. Other topics being given attention are; cost of production survey; scab research; soils high in phosphate to improve cooking quality and avoid excessive mechanical injury; grade enforcement; control of bacterial ring rot; variety tests; toxic effects of DDT; high yield competitions and freight reduction on seed from Northern Ontario.

The Potato Committee, Ontario Crop Improvement Association met recently (April 20th) at the Parliament Buildings, Toronto for their spring session. Reports were heard from Departmental Officials con-

cerning various angles, and discussion centered around timely subjects relative to the industry. These included resolutions passed at a recent annual meeting, supplies on hand and price support program, high yield contests, bacterial ring rot program, revision of price lists, certification matters, grade enforcement, disposal of culls, control of weeds by pre-emergence sprays, and policy for seed production in Northern Ontario.

Of particular interest was the report by Dr. H. L. Patterson, Director, Farm Economics Branch on Cost of Production Survey and another from Dr. G. H. Berkeley, St. Catharine's on the subject of the cooperative Scab Research Project.

Grower representatives were very much concerned about the Dominion-Provincial Warehousing Policy and urged the early establishment of central storage grading and packaging facilities in concentrated potato-producing areas. Other timely topics which received attention were the effects of increased quantities of phosphate on the cooking quality of potatoes, and the reported dangers from accumulated amounts of DDT in the human body and on the growth of crops following potatoes in the rotation.—R. E. GOODIN.

CHARLES FREDERICK CLARK—1873-1949

F. J. STEVENSON[1]

Dr. Charles Frederick Clark died at his home in Riverside, California, on May 8, 1949. He will long be remembered for his work in potato breeding in recognition of which he was elected an honorary member of the Potato Association of America at its meeting in Chicago, December 1947.

Dr. Clark was born at Glover, Vermont, August 13, 1873. He received a Bachelor of Science degree from the University of Vermont in 1897, a Master of Science from Cornell University in 1907, and a Ph.D. from the same institution in 1909. He worked as an agronomist and plant breeder at Cornell University from 1906-1910 when he accepted a position with the Bureau of Plant Industry. Although he retired in 1941 he never lost interest in potato breeding, potato varietal classification, and other investigational work. At the time of his death he was actively engaged in revising United States Department of Agriculture Circular No. 741 entitled, "Descriptions of and Key to American Potato Varieties."

[1]Principal Geneticist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture.

His work and publications are a monument to his memory, but his most outstanding contribution to the industry is the Katahdin potato. It was of great satisfaction to Dr. Clark that this variety was accepted so generally by growers. About two months before he died he wrote: "The widespread endorsement of the Katahdin by the potato growers of this country as indicated by the volume of seed produced is very gratifying. When it was released to growers 17 years ago I had no expectation that it would ever occupy such an important position in the potato industry. I remember that during the early days of testing the Katahdin to determine its qualifications one of our associates remarked: 'You have got to go some to beat the Rural New Yorker.' Today the Rural New Yorker is listed in the certified seed production report as one of the less important varieties with a production in 1948 of 42,005 bushels compared with 13,385,278 bushels for Katahdin. Katahdin was not an accidental discovery in our progenies but was the result of much study and effort in the selection of the parents which were used in the cross, as at that time resistance to mild mosaic and fertile pollen were almost non-existent in the material we had available."

Painstaking, thoughtful work was typical of the man. He was kind and courteous and in his dealings with his associates he lived closely to the Golden Rule. He was always a Christian gentleman.

BOOK REVIEW

POTATO PRODUCTION — E. V. HARDENBURG

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Here is a treatise written primarily as a college text but so designed as to be useful also for potato growers, for commercial interests and for teachers in secondary schools. The book covers almost every phase important to the potato industry. Included among its 17 chapters are such topics as botany and plant development, climatic and soil relationships, rotation and soil management, fertilization, seed, planting, varieties, disease and insect control, tuber defects, harvesting, storage, grading, marketing, quality, breeding and the economics of production. All subject matter is based on the author's teaching and research experience and a review of research of the past 30 years. Over 200 references to experimental work are cited in the text. Included among the 129 illustrations are the 26 varieties of potatoes now commercially important in the United States and Canada and nearly all of the tuber defects to which the potato is subject. There are 63 tables of data each of which is cited

as an example of results of the best research on the subject being discussed. It is indeed the only up-to-date potato text now available in this country.

To the credit of the publisher, the book is printed in very legible type on glossy paper and bound in heavy brown cover. The illustrations are especially clear and instructive of some point under discussion. Available from Comstock Publishing Company, Ithaca, N. Y. $3.00.

STATEMENT BY THE NATIONAL POTATO COUNCIL

Testimony of the National Potato Council before a Special Subcommittee of the House Committee on Agriculture, Honorable Stephen Pace of Georgia, Chairman, presented by Claude E. Botkin, farmer of Arvin, California, on behalf of the National Potato Council. This statement contains the recommendations of members of the National Potato Council as condensed and summarized by a Special Program Committee composed of Mr. Botkin, Mr. C. C. McIntire, Perham, Maine; Mr. William M. Case, Grand Forks, North Dakota; Mr. John Wickham, Cutchogue, Long Island, New York.

The National Potato Council is an organization of potato growers with members in all important producing areas. The Council was organized in May 1948 and incorporated February 2, 1949, in Washington, D. C. Most of the commercial production of white potatoes in the United States is represented in the Council's membership.

Our officers are S. A. Wathen, Fort Fairfield, Maine, President; W. B. Camp, Bakersfield, California, Vice President; John C. Broome, Aurora, North Carolina, Secretary; and William B. Duryee of Allentown, New Jersey, Treasurer.

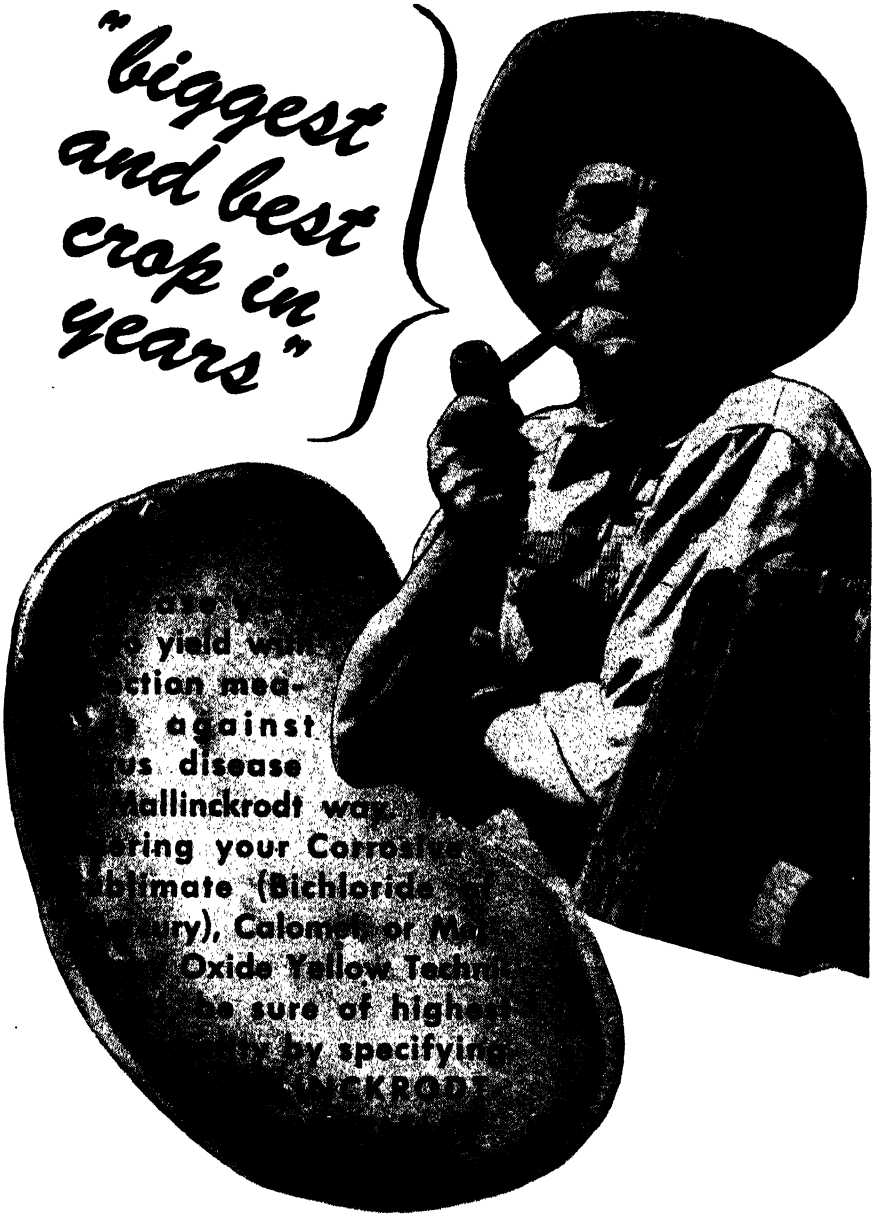
Potato producers of the United States, speaking through the National Potato Council, are very appreciative of this opportunity to appear before this Subcommittee to give you the benefit of our knowledge and experience in your worthy attempt to find a solution to our perplexing agricultural problems.

First of all, our farmers are keenly conscious of the fact that potatoes have become the "whipping boy" of the agricultural price support program. Therefore, we welcome this opportunity to say to you gentlemen that the actual operation of this program is not as potato men expected it to be, nor is it as they desire it to be.

The results have been due more to the exceptionally favorable climatic conditions that predominated the last few years, than to the intention of potato men, or to any failures of proper planning on the part of the Department of Agriculture.

As a matter of fact, potato growers, on the whole, have done almost exactly what the Department has requested of them under the programs that have been in effect.

"biggest and best crop in years"



As a group, potato farmers have complied with the Department's acreage program. In each of the last three years, the potato planted acreage has not even equalled the national acreage recommended by the Department. The indicated 1949 acreage is 1,900,000 acres, the lowest in seventy years.

In view of this wholehearted compliance with the program, it is obvious that the costs of the potato program have been due primarily to high per acre yields and to a sharp falling off in consumption.

In addition to the unusually favorable climatic conditions, there have been other factors, such as the use of new types of insecticides, and improved cultural practices.

The National Potato Council is frank to say that potato growers themselves are deeply concerned over the cost of the program and have repeatedly sought methods whereby it might be reduced.

The record on this is rather complete. As far back as May, 1948, potato growers, meeting here in Washington, recommended to their Senators and Representatives that changes be made in the potato price support program. They worked out what they thought, at that time, was a program that was practical, workable, fair to the consumer and equitable to the potato grower.

We would like to remind this Subcommittee of the most pertinent recommendations at that time:

1. That potatoes be supported on a flexible price support basis which would allow for adjustment as circumstances seemed to require.

2. They recommended that potatoes be supported at a price not less than 60 per cent nor more than 90 per cent of parity. They specifically recommended a support price materially lower than the 90 per cent then in effect.

3. They asked that, where feasible, marketing agreements be made one of the requirements of eligibility for price support, thus guaranteeing to the consumers the best that was produced.

a. We do not believe it is right for the Government to be buying good potatoes for diversion while industry is putting the culls on the market.

b. We feel that under the price support program we are obliged to give the consumer the best grades and not the poorest.

4. They recommended that acreage controls, production and marketing controls and other means be made available to the Secretary to use as circumstances demanded.

Following those recommendations, the Secretary of Agriculture reduced the rate of the support price for potatoes from 90 to 60 per cent

of parity and potato producers have accepted and are supporting this very sharp reduction in the support price.

Again, as recently as February 23, 1949, the National Potato Council gave full approval to this lowered support price program by saying to Members of Congress, and to the Department of Agriculture, that it believed the current program should be given a fair trial before changes were made.

For the last two days, the National Potato Council has again been in session and again welcomes the opportunity to present to this group our recommendations for what we think would be a sound and workable program that would be fair to the grower, fair to the consumer and satisfactory from a standpoint of administration by the Department.

In brief, we present the following main points that we feel should be incorporated in any long-time agricultural program developed by this Congress:

1. We recommend that the flexible price support system allowing the Secretary to set support prices from 60 to 90 per cent of parity be retained.

2. We recommend that any price support be contingent upon compliance with acreage goals and also marketing agreements, wherever feasible. We believe marketing agreements will provide for the consumer the better grades of potatoes.

3. We recommend that, if practical, a program to make possible the use of compensatory payments or production payments be developed and made available to the Department for use if necessary to enforce compliance with production programs.

4. We recommend that a definite formula for determining state potato acreage allotments or goals be incorporated in long-time legislation.

Potatoes are a vital food crop equal in importance to any crop produced by American farmers.

Constructive progress has been made in adjustment or acreage in an attempt to bring production in line with domestic needs.

There are many adjustments ahead in all segments of our national economy. It is our feeling that the difficulties of the potato industry are a forerunner of some of these problems which eventually will be confronting other groups in our nation.

Potato growers have been the first farmers of this country to specifically set forth their ideas and plans for a peacetime program for their industry. As has been stated, this was basically set forth a year ago and is reaffirmed in our statement today.

ERRATUM

The graphs are the Figs. 1 and 2 referred to on pages 49 and 52 of the February 1949 issue in the article entitled "The Effect of Time of Harvest, Variety and tSorage of the Ascorbic Acid Content of Potato Tubers" by W. C. Kelly and G. F. Somers.

Figure 1

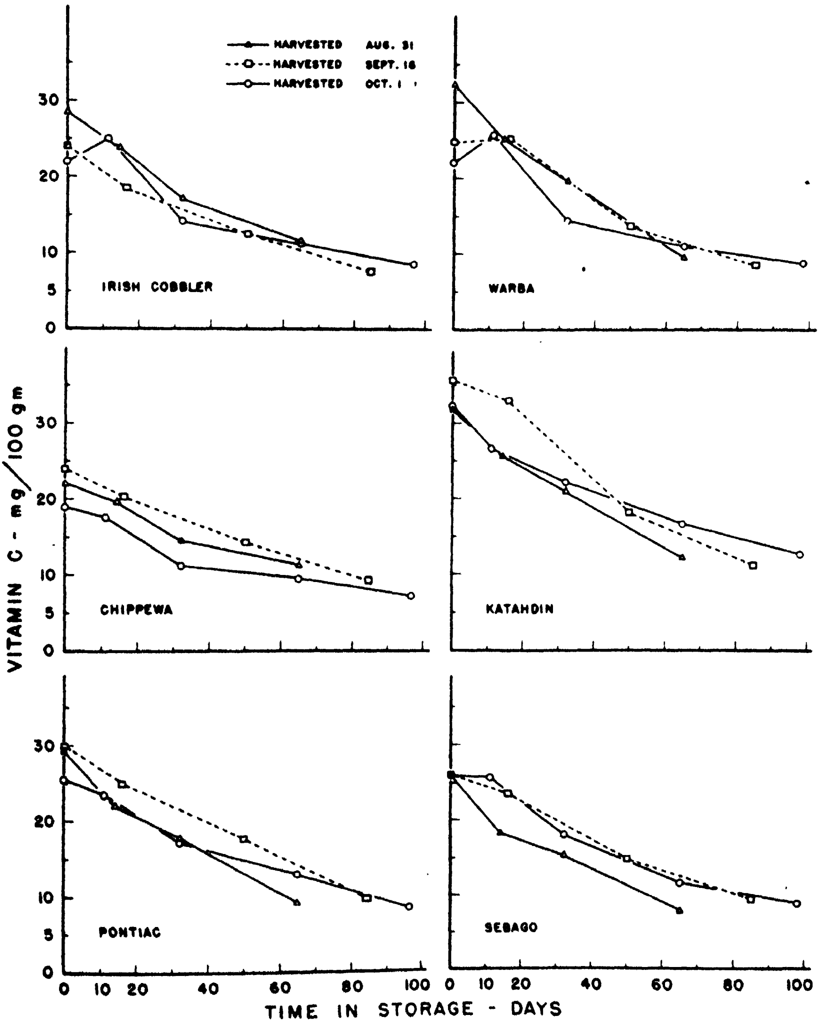
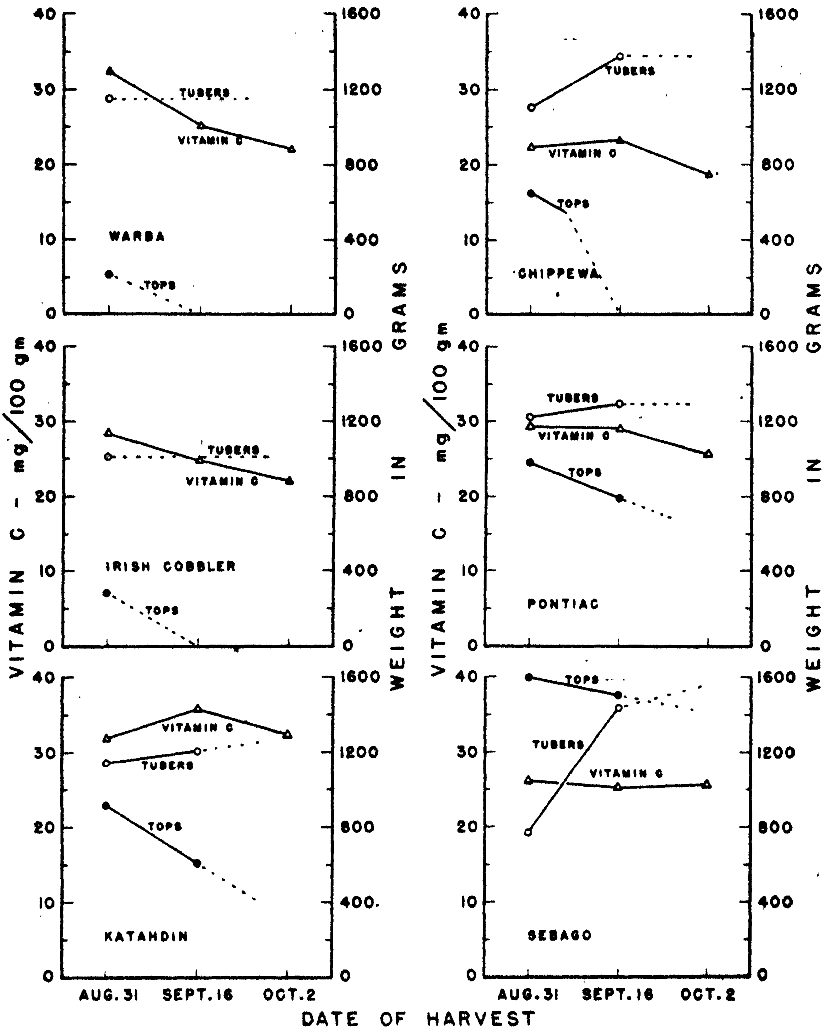


Figure 2


40
30
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10
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1600
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800
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TUBERS
VITAMIN C
WARBA
TOPS
TUBERS
VITAMIN C
TOPS
CHIPPEWA
IRISH COBBLER
PONTIAC
KATAHDIN
SEBAGO
VITAMIN C - mg/100 gm
WEIGHT IN GRAMS
AUG. 31
SEPT. 16
OCT. 2
DATE OF HARVEST

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RING ROT OF POTATOES[1]

Part I of this article was printed in April, 1949.

Part II—Substitutes for boiling water as knife disinfestants in preventing the spread of *Corynebacterium sepedonicum* (Spieck, and Kott.) Skaptason and Burkholder.

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(ACCEPTED FOR PUBLICATION, MAR. 25, 1949)

Early in investigating ring rot of potatoes in Idaho, it became apparent that one of the most acute and immediate problems was to prevent the spread of the causal organism within any given lot of seed while being prepared for planting. It was first believed that treating the cut seed, immediately after cutting, with an adequate seed treating material, would suffice. Experimental evidence disproved this idea. Skaptason (5) offers a possible explanation.

[1]Published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper No. 298.

[2]Associate Plant Pathologist.

The author (3) has presented evidence showing the role played by the cutting knife in spreading the causal organism during the seed cutting process. It seemed apparent therefore that treating the knife with an adequate disinfestant, by a continuous process, would go far in preventing the spread of the organism. To apply such a method to the usual seed cutting equipment used in Idaho presented difficulties. In Idaho, the usual procedure is to cut the seed with knives held in a horizontal cutting platform. The platform lies immediately below a hopper which automatically feeds the tubers to the cutters. To overcome the difficulty, a disc-shaped knife was substituted which rotated constantly through a disinfesting solution. In Colorado, Paschal (2) and his associates, have solved the problem very satisfactorily, by a method which disinfests a double-edged stationary knife.

Any material used as a disinfestant for a disc knife must possess two qualifications. It must be instantaneous in its action, and it must retain its toxic properties in spite of the diluting effect of juices from the potatoes. Boiling water possesses the necessary qualifications. Under some circumstances, however, it is difficult if not impossible to heat the water. A substitute for hot water would therefore be desirable. This paper concerns the reaction of two such materials, one a chlorine containing compound (B-K)[3], the other a thyr... ntaining material (Therapogen).[4]

Experimental Procedure

For each year's test, a power driven disc-shaped knife was used. While in use it revolved through a 3-gallon reservoir containing the bactericide. Russet Burbank potatoes were used in the tests. In 1942 the seed contained 5 per cent infected tubers. The seed was cut in such a manner that the percentage of infected seed pieces was not changed. The originally infected seed pieces were planted with the remainder of the seed.

In 1943, the seed containing 4 per cent infected tubers, was cut in a definite order, equally distributed. Such infected seed pieces were discarded and not planted. In 1944, 1945, 1946 and 1947, the knife was infested by pressing an infected tuber against each side of it, just before turning into bathing solution. Clean tubers were cut as the knife emerged.

[3]Contains 50 per cent chlorine and is manufactured by Pennsylvania Salt Manufacturing Company.

[4]Contains thymol, sodium brom para phenyl phenate, naphthalene, [illegible] thymene and terpineol in a soap solution, alcohol 16 per cent, manufactured [illegible] Theo. Meyer Est.

Two materials, based on preliminary tests, were compared with boiling water, as knife disinfestants. They were varying strengths of solution of B. K. and Therapogen. B. K. powder was first used in 1942 in a solution containing 8,000 p.p.m. of chlorine. In 1943 and 1944 solutions containing 5,000 p.p.m. were used and in 1945, the last year it was used, the solution contained 10,000 p.p.m. of chlorine.

Use of Therapogen was first made in 1944 as a 5 per cent solution. Ten per cent solutions were used in subsequent years, with much better results.

RESULTS

B. K. and Therapogen were both capable of disinfesting a rotating knife. However, solutions of the two materials, in these tests, were used but once, and then only while a small number of tubers were beng cut. Accordingly, no knowledge was obtained concerning the length of time over which the material would continue to be effective. That there might be some loss in the materials' effectiveness, with continued use, has been demonstrated by Kreutzer (1) and his associates, in the case of mercuric bichloride. It is common knowledge that chlorine solutions rapidly lose their effectiveness with use.

Data in tabl[illegible] show the relative merits of B.K. and Therapogen in comparis[illegible] with boiling water as a knife disinfestant. Under conditions of the tests, either material was equal to boiling water in preventing spread of the bacteria. Longevity of effectiveness is a merit which any such material must possess in order to be useful. In later tests this quality was ascertained for both materials.

Theophilus and Shaw (6) have given a method for testing the strength of chlorine solutions. This method was used to test the strength of the B.K. solution at certain intervals during the seed cutting process. Table 2 shows how rapidly the strength of the chlorine solution decreases. Beginning with a solution containing 11,579 p.p.m. of chlorine, samples of the solution were tested after cutting ten sacks of potatoes at intervals of one sack. After the tenth sack had been cut the chlorine was reduced to a little more than 50 p.p.m. Since, as is shown in table 1, the chlorine solutions in dilutions of 5,000 p.p.m. were not adequate in disinfesting the knife, it will be noted that after cutting three sacks of potatoes the strength of the bathing solution (3 gallons) had been reduced to 1,325 p.p.m.

Since no chemical test was available with which to test the Ther[illegible]en bathing solution, it was therefore tested at certain intervals in cutting process by exposing the knife to infestation and at the same

TABLE 1.—*Comparative value of B.K. and therapogen as substitutes for boiling water as knife disinfestants, when applied to a rotating disc cutting knife.*

Per cent Ring Rot

Year	Check	Per cent Ring Rot B.K.	Hot H_2O	Therapogen
1942[a]	73.8	(8000 p.p.m.) 2.2		
1943[b]	20.0	(5000 p.p.m.) 5.1	6.1	
1944[c]	75.3	(5000 p.p.m.) 32.7	3.0	(5 per cent) 20.0
1945[c]	94.0	(10,000 p.p.m.) 2.0	0	(10 per cent) 2.0
1946[c]	94.0		4	(10 per cent) 4.0
1947[c]	14.0		6	(10 per cent) 0.0

(a) 1942 - Seed contained 5 per cent infected tubers (infected pieces planted).
(b) 1943 - Seed contained 4 per cent infected tubers (infected pieces discarded).
(c) 1944)
1945) Seed contained no infected tubers (infected tubers held against knife).
1946)
1947)

TABLE 2.—*Rate of reduction in strength of B.K. solution* (10,000 p.p.m) *when used to sterilize a rotary disc seed potato cutting knife.*

Sample	p.p.m. Chlorine	Sample	p.p.m. Chlorine
Original solution before use	11,579	After cutting five sacks	301.5
After cutting one sack	10,670	After cutting six sacks	206.0
After cutting two sacks	6,717.5	After cutting seven sacks	28.0
After cutting three sacks	1,302.5	After cutting eight sacks	24.5
After cutting four sacks	1,109.5	After cutting nine sacks	35.0
		After cutting ten sacks	53.5

time cut a test lot of seed tubers. The latter were planted and the crop examined at harvest for the presence of ring rot bacteria, by the gram stain test. (4) Data in table 3 pertain to this phase of the experiment. It will be noted that after having cut 20 sacks of potatoes, a 10 per cent solution of Therapogen was still capable of disinfesting the knife to the extent that no ring rot appeared in the resulting crop.

TABLE 3.—*Longevity of the effectiveness of a* 10 *per cent solution of therapogen as a knife disinfestant in preventing the spread of Corynebacterium sepedonicum (Spieckermann and Kotthoff) Skaptason and Burkholder.*

Sample	Per cent Disease	Sample	Disease Per cent
Check: Knife not infested clean seed	0	Knife infested, 10 per cent therapogen, after cutting three sacks	0
Check: Knife infested, no knife treatment	14	Knife infested, 10 per cent therapogen, after cutting four sacks	0
Knife infested. Boiling water treatment	6	Knife infested, 10 per cen therapogen, after cutting five sacks	0
Knife infested, 10 per cent therapogen, original solution	0	Knife infested, 10 per cent therapogen, after cutting ten sacks	0
Knife infested, 10 per cent therapogen after cutting one sack	0	Knife infested, 10 per cent therapogen, after cutting twenty sacks	0
Knife infested, 10 per cent therapogen, after cutting two sacks	0	Check, knife not infested clean seed	0

DISCUSSION AND SUMMARY

Boiling water is an excellent material with which to disinfest a rotating disc seed potato cutting knife. However, some operators find it difficult to heat the water. Two substitutes are suggested—B.K., a chlorine containing compound; and Therapogen, a thymol containing solution.

B.K. was found to be inadequate, since it loses its effectiveness too rapidly with use. Under the conditions of the tests herein reported Therapogen proved to be a good substitute. It was equal to boiling water in its ability to disinfest the knife, and remained effective after long use.

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THE EFFECT ON THE YIELD OF POTATOES OF INCORPORATING 2,4-D IN THE REGULAR SPRAY

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(Accepted for publication, Mar. 23, 1949)

Preliminary trials have shown that the growth substance 2,4-D may be successfully incorporated in the potato spray. Bradley and Ellis (1) reported no decrease in yield when as much as .87 pound of actual 2,4-dichlorophenoxyacetic acid was applied in the potato spray for the variety Katahdin. Ennis *et. al.* (2) had previously observed that the Cobbler variety of potato could be treated with 2,4-D without decreasing the yield and in 1948 Thompson and Shuel (4) reported that neither the yield nor cooking quality of Katahdin potatoes was changed by treatment with 2,4-D. The 2,4-D was not applied in the regular insecticide-fungicide spray.

A number of questions relative to the use of this growth substance in future spray programs were then considered: The effect of the growth substance on the tuber which was to be used for seed, the quantity of chemical which could be applied, the stage of growth at which the growth substance should be applied, the compatibility of 2,4-D with several fungicides and the influence of variety on the response to the treatment.

The experiments reported here were designed to give answers to some of these practical questions which the grower must know in order to make use of this weed killer with some assurance of success.

Materials and Methods

All spray material applied for the experiments reported in this paper were applied with a four-row power sprayer at 400 lbs. of pressure per square inch. In the case of the two-row split plots in the variety trial, half of the boom was blocked so that only two rows were being sprayed at one time. Materials were mixed in a separate container and carried on a platform. By this means the sprayer tank was by-passed and contamination of the tank was avoided. This then required only the cleaning of the pump and spray lines.

All plots were laid out on a medium acid muck soil and fertilized with 1000 lbs. of 0-10-20 fertilizer.

Results

Experiment 1 deals with the effect of the chemical 2,4-D on the tuber when used for seed the year following spraying. Tubers of the Katahdin variety from the experiment reported by Bradley and Ellis (1) were planted in five replicated blocks. Only potatoes from the .437 and .875 pound per acre of acid treatments were compared to the untreated plots. The tubers from the replications of each treatment of the 1947 experiments were bulked and then divided for planting. No storage breakdown was observed on the treated potatoes which had been held over from 1947.

Table 1.—*Effect of 2,4-D* plant sprays on potatoes for seed*

Treatment	Bushels per Acre No. 1 Size Katahdin Potatoes**
1. Check***	533
2. .437 pound of Acid	511
3. .875 pound of Acid	519
(Yield differences not significant)	

* 2,4-dichlorophenoxyacetic acid in the form of 70 per cent sodium salt of 2,4-D
** Yields from single row 35 hill plots
*** Regular spray made up of basic copper sulfate—4 pounds DDT—2 pounds 50 per cent wettable in 100 gallons of water

The yield of potatoes from these plots show no depression in yield when tubers are used for seed which had been grown on plants sprayed with as much as .875 pound 2,4-D acid per acre.

Experiment 2 deals with rate of application of 2,4-D in the potato spray. Four rates of application and an untreated check were replicated four times. The 2,4-D was applied 38 days after planting and in the third of six copper zinc DDT sprays. Each plot was four rows wide by 100 feet long. Table 2 gives the treatments and bushels per acre taken from 80 feet of the center two rows.

The data in table 2 show no differences in yield when as much as 2.1 pounds of 2,4-D acid equivalent were applied.

Experiment 3 furnishes data on when to spray, the effect on set of tubers and compatibility with several fungicides. The series consisted of six replications of 10 treatments. The plots were four rows wide by 100 feet long.

The treatments consisted of single applications when the potatoes were 3, 8 and 16 inches high, the growth substances included in every spray, and two formulations carrying the equivalent amount of acid in the two sprays applied when the potatoes were 8 and 16 inches tall.

TABLE 2.—*The rate of application of 2,4-D in the spray* and yield of potatoes*

Treatment Pounds of 2,4-D Acid / Acre	Bushels per Acre No. 1 Size Katahdin Potatoes
1. Check	315
2. .35 pound of Acid	340
3. .7 pound of Acid	307
4. 1.44 pounds of Acid	280
5. 2.1 pounds of Acid	325 N.S.

*6-5-100 Bordeaux + 1 pt. 25 per cent emulsifiable DDT.

The compatibility of several named fungicides with 2,4-D was also compared. These include Parzate, Zerlate, Dithane D-14 and copper-zinc-lime.

The effect of these treatments on set of tubers was determined by digging 20 consecutive hills from each of the larger areas in order to make tuber counts.

Table 3 shows the treatment, yield per acre of No. 1 size tubers and number of tubers per hill for this trial. Eighty foot sections of the two center rows were dug for yield trials.

The yield of potatoes given in table 3 lacks significance at the 5 per cent level. The yields do indicate a trend which should be studied further. It appears that single applications may be made to the potato at any stage of growth and that two applications may be made when sprays are spaced as much as 12 days apart. When potatoes were sprayed with 2,4-D in every spray or with the butyl ester of 2,4-D in two sprays, the foliage was distorted throughout the season and while the yield is not specifically significant, the trend should be considered seriously.

It is further observed from these data that the growth substance 2,4-D is compatible with the fungicides used. Broad leaf weed control was complete and all yields from plots on which an organic fungicide was substituted for the copper zinc spray were as high or higher than the check plot.

Six spray applications were made during the season. Fungicides and insecticides were applied each time. The 2,4-D was applied as indicated in the table. The dates of application and height of the plants were: June 30—3 inches; July 12—8 inches; July 24—16 inches; and fungicide DDT sprays were applied July 17, August 10 and August 24.

It had previously been suggested that spraying the potato plant with 2,4-D might increase the number of tubers per hill. These data indicate that all treatments were higher than the check but the differences

under the conditions of this experiment were not quite significant at the 5 per cent level. There is a definite trend toward increasing the set and further study will be necessary.

TABLE 3.—*Yield of potatoes treated at different stages of growth with 2,4-D and with different fungicides in the spray*

Insecticide Fungicide Spray	(Treatment) 2,4-D Applied	Height of Plants in Inches	Bushels per Acre	Average No. of Tubers per Hill
1. Base Spray*	.52 pound acid equivalent as sodium salt of 2,4-D	3	489	8.2
2. " "	"	8	469	7.6
3. " "	"	16	470	7.6
4. " "	"	all sprays	390	9.0
5. " "	"	8 and 16	450	9.0
6. " "	.52 pound acid equivalent as butyl ester	8 and 16	384	9.0
7. Parzate	.52 pound acid equivalent as sodium salt of 2,4-D	8 and 16	462	7.3
8. Zerlate	"	8 and 16	520	7.3
9. Dithane D-14	"	8 and 16	478	9.3
10. Base Spray	"		430	7.2
			N.S.	N.S.

* 6 pounds Copper Sulfate
5 pounds Hydrated Lime
1 pound Saf-n-led
2 pounds DDT

Experiment 4 deals with varietal response to treatment with 2,4-D. Six varieties—Katahdin, Chippewa, Sebago, Russet Rural, Bliss Triumph and Irish Cobbler—were planted in 80 hill 2-row split plots. These potatoes were sprayed with the copper-zinc-lime DDT spray on June 26, June 30, July 10, July 12, July 17, August 9 and August 24. On July 12 and July 17 the 2,4-D was included in the spray. Soon after the application on July 12 a rain of 1.03 inches fell and although the plan did not call for two sprays of 2,4-D in rapid succession, the treatment was repeated. Table 4 lists the six varieties of potatoes and gives the percentage of depression in yield from the two applications of 2,4-D.

The data show that there is a difference in the response of the different varieties to the treatment. The Russet Rural variety apparently had the least capacity to recover from the effect of the treatment. The commonly grown varieties were of about the same order in relation

TABLE 4.—*Effect on yield of two treatments of .52 pound of 2,4-D acid per acre applied in a five day interval on six varieties of potatoes*

Variety	Yield in Bushels per Acre*		Per cent Loss in Yield from Treatment
	Two Treatments .52 Pound 2,4-D Acid per Acre at 5-Day Interval	No. 2,4-D**	
1. Katahdin	430	623	31
2. Chippewa	290	424	32
3. Sebago	405	521	22
4. Russet Rural	224	593	62
5. Triumph	496	696	29
6. Cobbler	442	611	28

*No. 1 size.

**The effect of treatment is significant at the 1 per cent level and the varietal effect is significant at the 5 per cent level.

to effect on the yield. It will be necessary to survey all new varieties to determine this relationship.

DISCUSSION

The use of 2,4-D in the regular potato spray shows promise but should not be substituted for cultivation at the present time. It appears that there are no ill effects from the spray carried over in tubers to be used for seed. However, certified seed potato growers should not use 2,4-D unless approved by the certification agency since the effect may be confused with disease symptoms. The data here presented indicate that as much as 2.1 pounds of 2,4-D acid equivalent may be added at one time without depressing the yields.

It has also been observed from this data that the size of the plant may not be so important as the interval between sprays, and we may suggest from this that more than one spray would be possible each season provided a sufficient period of time elapses between treatments for the plant to recover. Potato plants are affected by the 2,4-D but the ability of the plant to recover determines the usefulness of the treatment.

The common fungicides were tested and since weed kill was observed and no depression in yield resulted, we may assume that the 2,4-D in the form of the sodium salt is compatible with these fungicides.

The data also indicate that the yield of potato may be depressed when applications of 2,4-D are applied at 5 day intervals. The minimum time lapse will need to be determined in order that the treatment may be safe for the grower to use.

Skin color changes were photographically recorded but actual color

measurements have not been made. Observations similar to Fults and Schaal (3) were made on Bliss Triumph tubers. The skin color was greatly intensified on the treated potatoes. On Russet Rural potatoes the brown color of the normal Russet potato became yellow-brown with treatment. No differences could be detected in the white skinned varieties.

Summary

1. Potatoes treated with as much as .875 pound of 2,4-D acid equivalent per acre as sodium salt did not break down in storage.
2. These potatoes, when used for seed, were not affected by the former treatment. Seed growers are warned not to use 2,4-D since the reaction on the plant might be confused with disease.
3. Amounts as high as 2.1 pounds of acid equivalent may be made in single applications without depressing the yield of Katahdin potatoes.
4. Present data do not indicate that 2,4-D treatment will consistently increase the set of tubers on muck soil.
5. When making single applications, the size of the plant when treatment is made does not affect the yield.
6. 2,4-D is compatible with some of the common fungicides used in potato spraying, *i. e.* Basic Copper, Bordeaux mixture, Parzate, Zerlate and Dithane D-14.
7. Decrease in yield of the potato crop resulted when two sprays were applied at 5-day intervals, the Russet Rural variety being affected more severely than other varieties.
8. Visible changes in skin color result from a spray treatment of .52 pound of 2,4-D acid. Skin color in Triumph was intensified.

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SUMMARY OF PAPERS PRESENTED AT THE POTATO CONFERENCE HELD AT THE EASTERN REGIONAL RESEARCH LABORATORY OCTOBER 19-21, 1948

(Continued from May Issue)

Problems of the Potato Chip Industry

The discussion was based primarily on the problems of the Wise Potato Chip Company, which are closely similar to those of the other 400 potato chip manufacturers.

The National Potato Chip Institute appropriated $5,000.00 last year for research on the problems of the chip manufacturer, but not enough time had elapsed for this program to make real progress.

Of all the known varieties (estimated to be more than 300), the Russet appears best for chip production. A suitable substitute for the Russet is desirable, however, because of its low yield per acre and susceptibility to disease. Katahdins and the new variety, Kennebec, give higher yields per acre, but chips made from them have little taste. There is some reason to believe that the Russet will not disappear entirely from the Eastern States; the Western States can use Cobblers.

The tendency to develop new varieties for table stock; *i.e.*, with preference given to appearance and cooking quality, will not necessarily lead to varieties suitable for chip manufacture. Potatoes of low moisture content are needed for chip production to obtain maximum purchase value, maximum weight yield of chips, and low absorption of oil.

Not only are quality and variety important, but size also plays a role in the production of potato chips. Even though U. S. No. 1 is used, it is sometimes necessary to cut the larger tubers (thus increasing labor costs) to facilitate packing and decrease breakage with the automatic packaging machines.

It is necessary to keep the sugar content at a low level to produce the light golden brown chip acceptable to the consumer. The chemical composition has a direct bearing on the curing and flavor. Enzymic action and temperature determine the curing time when the initial temperature and reducing sugar level are known. Considerable information has already been obtained on the relationship between starch content, temperature and curing time; in some instances it is possible to predict suitable temperatures and curing periods.

Diseases caused by bacteria and viruses in the field and on storage are troublesome. Although every lot of potatoes is carefully inspected, the evils and problems of disease cannot be entirely eliminated. Even

if field diseases could be completely eliminated by judicious buying, it still would be necessary to combat disease in storage. As soon as disease is discovered in potatoes intended for chip manufacture, the disease is identified and the storage temperature is adjusted to retard spreading of the disease. Some bacteria apparently cause an increase in the sugar content. Sometimes the temperature can be adjusted to increase respiration and transpiration rate and the removal of the unwanted reducing sugar. The reducing sugar is undesirable because it causes the formation of hydroxymethylfurfural and subsequent darkening of the chip. Each lot of potatoes presents its own peculiar disease problems, and the chip manufacturer must strive constantly to keep disease at a minimum. Since the potatoes are obtained from Florida to Maine, the problem is national rather than local.

The chip manufacturer must also maintain an interest in the development and use of insecticides. Benzene hexachloride is a classic example of the disastrous results that may be caused by the injudicious use of new insecticides. The chip manufacturer must guard against the purchase of potatoes that have been sprayed with materials having an adverse effect upon flavor and taste.

The former practice of selecting potatoes principally by appearance has yielded to dependence on various chemical tests. From the original potato to finished products, the results of chemical tests are carefully recorded. The laboratory regularly tests potatoes in storage to determine whether the temperature should be adjusted to minimize sugar formation. When the concentration of reducing sugar is brought to a minimum, the proper frying temperature is determined in the laboratory. The laboratory also tests the frying oil, cellophane, fuel oil, cooking oils, packaging materials, and antioxidants.

Flavor and organoleptic methods are no longer used exclusively to determine the quality of chips. These methods are supplemented by chemical tests for aldehydes. Peroxide formation is used as an indication of incipient rancidity.

It is hoped eventually to solve all or most of the problems associated with chip manufacture and to continue providing the consumer with a tasty, wholesome, nutritious, and attractively packaged food—a food that has already become an important item in the diet and budget of Mr. and Mrs. America.—PAUL A. ZANDER., *Wise Potato Chip Co., Berwick, Pa.*

What Are the Present Needs in Potato Research?

Summing up the present needs of potato research would be an easy task if the only factor involved were making a list of all the things

we might think up for the laboratories to work on. But since time is essential and priority important, it is necessary to select that which seems likely to give the broadest kind of results in the light of the present difficulties of the industry. A research program is of necessity a long-range affair and expediency should have little part in it. Nevertheless, we should put "first things first" if we expect to begin a long-delayed improvement.

Our recommendations should recognize, it seems to me, the excellent work already done and being done by the Potato Advisory Committee established under the Research and Marketing Act. That Committee has repeatedly stressed that in research top priority be given to projects for expanding uses *other than as human food in fresh form.* At the same time the importance of some projects in production and marketing has not been ignored. That Committee continues to devote painstaking attention to our needs in relation to the over-all administration of the Act.

Production Research

On the production side, the breeding program merits continued emphasis, since from it will come, as they have in the past, the productive, disease-resistant and higher quality varieties to replace present ones that inevitably deteriorate under cultivation. Their endurance under modern high-speed harvesting methods may well be a quality to seek, and table quality will assume a larger importance as we learn more about this intangible factor from the results of the cooking test research. High starch content may or may not be desirable in table varieties, depending on what we learn about mealiness *versus* moist-flesh in different forms of cooking. It must be kept in mind that the Government already possesses a large and well-staffed extension service whose work it is to carry out the results of research to growers and make such results immediately available through demonstration.

Marketing Research

Recent surveys tell us that combination grocery stores sell about 37 per cent of all food eaten in the United States. It is said that such stores sell about 42 per cent of the produce consumed. This leaves the remainder of food sold to such distribution agencies as the government, military buyers, specialty stores such as fruit and vegetable markets, and institutions including restaurants, hotels, colleges and schools, factory lunch rooms, railroad dining cars, clubs and hospitals. It appears, therefore, that the institutional market may well account for nearly

one-half of our fresh sales. It is fortunate that we have with us my well-qualified colleague, Col. Paul Logan, who can discuss that phase of our market and its needs out of a very broad and well-rounded experience. I am going to leave that segment of the discussion entirely to him.

Retail Distribution Research

In retail distribution to the consumer, studies by the Government are already under way and reports from them are becoming available. Most of them have been of two types. In the first type, studies of buying behavior are made under existing conditions based upon observation and historical data. The second type consists of studies dealing with preferences, attitudes and opinions. It would seem advisable to conduct certain kinds of surveys under a third type, studies designed to evaluate preferences under controlled experiments. Observation of buying behavior alone does not assure that consumers were given a chance to buy the goods or services they wanted most, therefore it seems desirable to test them by actual offerings of goods of controlled quality, quantity and price.

The Department of Agriculture is already engaged, through contract with the organization I represent, in a nation-wide project for training retailers in better merchandising of fresh fruits and vegetables, including potatoes. In slightly less than a year we have trained nearly 7,000 retailers in over 40 cities in modern methods of preparation, display, care, pricing and merchandising, and the program is expanding. Average increases of approximately 30 per cent in the volume of fruit and vegetable business are reported from stores whose personnel have attended this carefully-planned, one-day course. We, in turn, are learning much about this important work in our chain of distribution—we too are learning to "think retail."

Future studies of consumer preference should include consumer types of package, more facts on preferences as applied to a larger group of cities, metropolitan *versus* rural or semi-rural communities; industrial *versus* non-industrial towns; buying habits of different income groups, and perhaps climatic and seasonal variations in consumption.

Since we have seen some indications that rough handling injures our product and reduces consumer acceptance, should we concentrate exclusively on better handling all along the line or is our principal package itself to blame? Could package research develop for us a container offering a better degree of protection than the 100-lb. bag affords, at the same time costing no more?

Inelastic Demand

A word about the phrase, "inelastic demand." We have been hearing this phrase applied to potatoes for a great many years now, and it seems time to examine it more closely. Do the economists who use it mean that the public will eat only about so many potatoes anyway, and nothing can be done about it? Or do they mean that, unlike certain other food items, such as perhaps citrus fruits or lettuce, there does not seem to exist the possibility of expanding consumption by one, two or three hundred per cent? The former would be a defeatist conclusion which a sales-minded industry would and should reject. I am inclined to believe it is not what "inelastic demand" is supposed to mean, since consumer surveys do not support such a proposal. In fact in its report on potato preferences among household consumers, the USDA says,

> "In a market of good quality, when prices shift upward, about 12 per cent reported that they buy less. When prices go down, 20 per cent reported they buy more."

And again,

> "While a great bulk of the consumers reported they buy a constant quantity of potatoes under most circumstances, there is a peripheral group around this core of buyers who are apparently sensitive to market conditions and who report that they expand and contract their volume of purchases as price and quality vary."

We can reasonably assume, I think, that the consumers have been affected in their preferences to some degree by our shortcomings in grading, packaging, advertising and merchandising in competition with other foods, and that we can, as an industry, bring about at least some increase in sales and consumption if we have the will to do it.

Transportation Important

Several excellent studies in railway and truck transportation, refrigeration in transit, care in terminal markets and in retail stores and losses in transportation from wholesalers to retailers are already under way. They may well be continued and expanded. Results of refrigeration tests on potatoes in transit inspire the thought that perhaps we need still another committee, to see that the results of research already completed are taken out of the files and acted upon by both growers and shippers, thus turning findings into practices. This may offer fertile ground for progress.

Utilization

We have had here an imposing array of information about progress in turning our low grades into food, industrial uses and feed. Coming along as it does with the accomplished fact of marketing agreements already established in 12 states, and available for use in controlling crop movement, this offers perhaps the most hopeful sign of improvement in that portion of our crop (and the major portion) which the consumer buys and pays us for. It offers at the same time perhaps our most effective argument in convincing the public that we seek self-help rather than a public dole.

Food Uses

Food outlets such as chips, dehydrates, canned and frozen potatoes and potato mixes are fairly well established and need only such continued improvement in processes and raw material development as will enable them to expand in volume and use. Flour and meal, while now manufactured in large volume, rest at present on an insecure foreign demand and need to be studied as products for which a domestic market of unknown potential must be found. This is both a laboratory and sales problem, to improve and lower the cost on the one hand, and to broaden its sales on the other. The industry needs to turn its attention to this question without delay.

Industrial Outlets

Potatoes as a source of alcohol present many problems, which have been ably presented. It may well be that their place in motor fuel manufacture, among other agricultural crops and wastes, will presently be found, unless our oil resources are larger than geologists say. They present a problem in transportation which seems capable of solution only if fuel prices rise or larger yields of high-starch potatoes find an economical place in our agriculture.

Other end-products of potato fermentation in the chemical field offer a continuing backlog of work for the chemist. The work in starch production is being watched by a capable and widespread industry, but should nevertheless have our continued support.

Livestock Feed

It is in the field of livestock feed development that the layman is tempted to offer the greatest amount of free advice to the scientist, and to make the strongest plea for accelerated effort. Feeding of culls and low grades in fresh form to livestock is a well established and extensive

practice, but it labors under definite limitations of bulk, weight and perishability, which have restricted its expansion in spite of what has been almost free distribution by the Government. Dehydrated potato feed and feed supplements derived from potatoes seem to offer one of the broadest outlets within the realm of immediate possibility.

The value of dehydrated potatoes as a stock feed is well established by experiment station tests in many states. It has been generally proven that they are nearly as valuable as corn for feeding most classes of livestock. Commercial feed manufacturers are aware of this, but because of their large-scale operations, and the fact that they must conform for rather long periods of time to published formulas, they cannot use dried potatoes until they have been guaranteed an ample and continuing supply.

It is true that feed supplies are on the increase as grain production catches up with world-wide demand. But rising transportation costs make grain feeds cost more in many areas where both potatoes and livestock are produced. A survey in the North Platte Valley has revealed that in that area there is a potential market for feeding lambs alone, for at least 15 thousand tons of dried potato feed annually. This is 2½ times the available local supply of dried cull potatoes, and also does not include another large outlet for cattle and hog feeding there. Similar surveys elsewhere would reveal even greater possibilities.

It seems therefore that we should undertake to determine what areas could use dried potatoes to advantage in or near the points where the culls, low grades or surplusses exist. Cheaper methods of drying, particularly in small-scale units, should be engineered. Perhaps this can be expedited through contracts with high-class, experienced engineering firms to perform this research. At the same time we should work with feed manufacturers toward developing both the market and the larger scale facilities necessary to supply it. In both activities we will need to locate such facilities so that transportation and handling costs can be held to a minimum.

Still another article of feed needs attention. Artificial feed supplements such as blackstrap molasses, beet molasses and low grade corn syrup are now in common use in large volume. Blackstrap currently costs over $30.00 per ton in tanker lots at east coast ports; much more inland. Why not develop a simple pressure-hydrolysis method of making a crude, dilute feed sweetener from cull potatoes? We should examine the practicability of doing this in small, low-cost installations near our grading warehouses in producing areas. We should also find out whether high concentration or artificial preservation is really nec-

essary, or whether such a product can be used up by local feeders promptly in more dilute form. Also, whether such a product contains additional nutrients or vitamins making it more valuable than as a sweetener alone.

There is ample evidence that such a product can be made. One leading distillery reports the development of an acid-hydrolized continuous process for converting grain mashes first to sugars and then to alcohol. It is even reported that hogs have been fattened from feeds sweetened with molasses made from sawdust. If such a product could be locally made from cull potatoes and then used to supplement feeds containing locally dried potatoes also, the advantages seem obvious.

In conclusion it may be repeated that if the recommendations given seem top-heavy on the side of utilization, it is so because of our double-barrelled problem of selling the best and processing the rest. If ways can be found to make a withholding of low grades more attractive, one-half of our problem of better grading will be solved. And it seems apparent from surveys so far conducted that better grading will help to turn the declining curve of consumption upward.—KRIS BEMIS, *United Fresh Fruit and Vegetable Association, Washington 9, D. C.*

WHAT THE RESTAURANT OPERATOR LOOKS FOR IN POTATOES

I am very happy to have had the privilege of listening to the wealth of useful information which has been presented at this conference, and I am grateful for the opportunity of presenting a few thoughts about the potato needs of the Public Feeding Industry. Mr. Bemis in his talk on the first day of your meeting keynoted the relative importance of the problems which confront potato producers when he said "we grow potatoes primarily as a food crop for use by consumers principally in fresh form," and "sales for non-food uses and for livestock feed are a form of safety valve for drawing off—first our low grades, and then our surplusses."

Since 1910 there has been a steady decline in the consumption of both white and sweet potatoes until in 1947, it was only 69 per cent of what it was at that time. Grain product consumption declined 26 per cent during the same period. Meat consumption had declined 14 per cent when in 1937 The American Meat Institute began a vigorous educational program upon the nutritional value and "food-satisfaction" of meat consumption. During the following ten years it moved from a minus 14 per cent on the down curve of consumption to a plus 5 per cent. In the meantime dairy products, sugar and sirups, fats and oils, eggs, fruits and vegetables—all showed substantial increases—the last

reaching a consumption rate of almost 160 per cent above the base period.

The decline in potato consumption is a great pity from a world food viewpoint because, outside of the rice eating areas, it is a fundamental food, abundant in quantity, economical in use, and excellent in nutrition. There are, of course, many contributing causes to this decline, most of which have been discussed at this meeting.

One important cause is the fallacious and unchecked opinion that potatoes are a fattening food. This belief has caused untold thousands of women to decrease or discontinue their use of potatoes. Let me illustrate the effect of this—as it goes on today—and as it will continue until a vigorous educational program changes the belief.

Between 1946 and 1948, over a two-year period, a most exhaustive nutritional and food preference study was made of 2182 people by Penn State College. Half of the subjects were men and half women. They were divided into 5-age groups (17-21) (22-26) (27-36) (37-46) (47-56). Their diets were self-selected. The amount of different kinds of food consumed was carefully recorded for each group. The foods were classified as (milk) (meat) (eggs) (dried legumes) (leafy green and yellow vegetables) (citrus fruits and tomatoes) (bread and cereals) (sugar) (fats), and (potatoes).

Here are the results on potatoes. The men ate 2 1/10 pounds per week and there were no noticeable difference in consumption between the male age groups. The women ate 1 2/10 pounds per week—which is only 57 per cent as much as the men ate—although in the total of food, the women ate 87 per cent as much as men. But there was a great difference in the consumption rate among the female age groups. The youngest and oldest of the groups ate the most. The 27-36 year group ate the least, and the 37-46 next to least. Yet these are the years when women are raising their children through their most important period of adolescence, and the attitude of the wife and mother toward potatoes is undoubtedly reflected in the consumption rate of the family.

But I have come here to discuss the needs of the Public Feeding Industry for improved potato service. This industry constitutes a major market for potatoes, and is one which should be given careful and continuous attention by potato men.

According to OPA statistics there are about 524,000 public feeding places in the United States, which annually provide some forty billion meals for our people. This is approximately a quarter of all the food consumed in America. Sixty-three million customers sit at the tables

and counters of our restaurants every day—and what they find there—good and poor—has an influence upon the home consumption rate of the same foods. If they find really wonderful hash brown or baked potatoes in the restaurant, they want to have the same at home. If they find gummy or watery mashed potatoes in the restaurant, they lay-off mashed potatoes at home.

The restaurant man for the past three years has been constantly bedeviled by increasing food and labor costs. In a well-run restaurant the food costs should be held at around 42 per cent of the sales dollar. When the cost recently rose to over 50 per cent there was no alternative but to raise menu prices—or cut portions. In a good operation the labor cost in a restaurant should be about 28 per cent of each sales dollar. In most areas it is now about 35 per cent and in the far west it is 45. This condition causes the restaurant manager to be very receptive to any sound and practical suggestion which will serve to reduce his labor cost.

Within these two cost areas—one on food, and the other on labor, in my opinion, lies a real opportunity to increase the consumption rate of potatoes by restaurants which, under proper conditions, will lower both food and labor costs and, at the same time, improve the standard of food service.

But the potato distribution will have to undergo considerable change if the improvements I have mentioned are to be realized. First, and most important I think, is a thorough understanding by all potato and restaurant men that there is no such thing as an "all purpose" potato; that while potatoes having certain physical characteristics may be used for a number of cooked dishes, they usually are especially good for one or two; and that selling or buying potatoes under the mere title of "Potatoes" is as absurdly inadequate as would be the purchase or sale of wheat or apples or automobiles under the empirical name of those products. Secondly, these same people must come to a realization that a variety name does not guarantee a constant uniformity of product. The difference between the same potato variety grown in Florida and New Jersey, in north and south Maine, on acid and non-acid soil is too well known to need further repetition. Thirdly, we must realize that all varieties change their physical characteristics as storage life progresses. And finally, that potatoes having certain characteristics are good for specific purposes, regardless of variety or area of growth. The first question to be answered and which needs research is where and how can these potato characteristics best be commercially determined. We all know that a potato with a specific

gravity of 1.09 or better is high in starch and therefore apt to be a good baker or masher, while one that is below 1.07 is soggy and apt to be good for salad work. We don't know as much as we should about the character of the starch or other constituents which cause stuffing, gray discolorization, dark spotting, etc. We all know that potatoes having a sugar content much over 3 per cent are not satisfactory for deep frying or chip manufacturing, and that the amount of reducing sugar and nitrogenous matter present is of greater importance than the total amount of sugar present. How can we measure these things so that the measurement will benefit the consumer? It seems obvious that the work must be done by the agency which moves them into retail or consumption channels.

Canners do not find it difficult to separate green peas on the basis of starch content by brine flotation. Potato men could do the same. Potato chip manufacturers almost universally are having their stocks measured for sugar content and, when necessary, have them conditioned for use by reducing the sugar content through 70° storage. Certainly the restaurant man who wants to serve perfect French fried potatoes would be willing and glad to pay a premium for a guarantee that potatoes purchased for that purpose would always be satisfactory.

Potato consumption would increase substantially in restaurants if every potato dish served could be of superb quality. Of course, a poor cook can spoil any kind of food, but restaurants staffed with poor cooks don't remain restaurants—or at least they never join the select 22 per cent which feeds 80 per cent of all the meals served by the entire industry.

Potatoes are a low cost item. If by excellence in service the consumption rate could be increased by one ounce per meal, the other costly item of poultry, fish or meat could be decreased by at least one-half ounce. A one-half ounce of 60 cent food being replaced by one ounce of 6 cent food would drop the food cost by 1½c. On the basis of potatoes being served at 2/3 of the meals, the one ounce increase would amount to over 2½ million pounds per day or about 960 million pounds per year. It is my firm belief that this can be done if the potato distributors will separate, package, and define their deliveries, and the consumers will use the potato properly. But the benefit would go far beyond the tonnage increase in restaurant use. It would create a home demand for better and more potatoes. This, together with a vigorous educational program, about the non-fattening quality of potatoes would start the per capita consumption curve back up.

The second phase is that of lowering the labor cost. Right now

restaurant men find it difficult to hire scullery people at from 80c to $1.00 per hour. In spite of that, there are less than 50 per cent who own mechanical peelers—because of the initial cost of the machine. This of course applies wholly to the 78 per cent group—not to the 22 per cent group. Mechanical friction peeling results in 18 to 20 per cent loss in smooth and 27 to 30 per cent loss in rough potatoes. Hand peeling losses are as high as 40 per cent. The potato is probably handled four to six times between the receiving platform and the stove. I don't happen to know of any time-motion study which has been made on the storing and make-ready work but what with peeling, cleaning utensils and machines, trash disposals, *etc.*, it must constitute a cost at least half as much as the cost of the potatoes. Now, most of that cost can be eliminated by the commercial peeling of potatoes. It is being successfully done now in several places, and within the next few years it will probably become standard procedure throughout all metropolitan areas.

When a restaurant man can buy peeled potatoes he gets a product which is 100 per cent usable, eliminates all the labor incident to peeling and to the cleaning that goes with it. He saves considerable storage space and increases work area space by the absence of peeling activities. If commercial peeling can be done for restaurants, it can also be done for the housewife. Steam pressure or caustic peeling will save from a half to 3/4 of present peeling losses. Dips are now available which will prevent discoloration.

We need more information about the physical characteristics of potatoes as related to cooking quality. We need information as to whether the pH of cooking water affects the starch or other constituents. We need research to develop speedy and sure methods of measuring potato characteristics and one that, at a reasonable cost, can be used by distributors in their present warehouses.

With this research accomplished, breeding programs could be pointed toward development of desired qualities and elimination of undesired ones. With this information we can make the *per capita* consumption climb a ladder. Without it we can keep on looking down the declining consumption path—or else, as was suggested the other day, import more Irishmen to eat potatoes.—PAUL P. LOGAN. *National Restaurant Association, Chicago, Ill.*

SECTIONAL NOTES

ALABAMA

Alabama, after trials and much anxiety, has harvested and marketed one of the best Irish potato crops in several years. The general cash

return was also the highest for our growers than for many years. This was because of the price paid to farmers for their potatoes. Our growers sold all their crop from a price range of $2.60 to $4.00 for No. 1 grade potatoes. Commercials, No. 1 size but out of No. 1 grade due to non-rot defects, sold for 15 cents less than the U. S. No. 1 grade. It has been estimated that our 10,000 acres in Baldwin County yielded nearly 100 bags of potatoes per acre, average. With the above prices it is easy to understand why we are pleased with returns. Escambia County, (Atmore area) did not have such a good yield because of weather and blight conditions but most of the growers made a fair profit with some few taking losses.

Just before harvest we had approximately 11 inches of rain in a week's time. Since the first few days of shipments did not carry well the ability of the crop to withstand shipment caused much concern. After a few days of dry weather the balance of the crop was mature and was carried to market in wonderful shape. This contributed to the steady and increasing demand for our potatoes at increasing price late in our season. Even though we had the worse dose of Late Blight in several years, there seemed to be no evidence that it caused potatoes to rot in transit or in the fields. It is apparent that our Triumphs and Sebagoes have been able to resist this threat when grown under our conditions.

It is generally accepted that we must control blight from now on not only because of yield but to be able to market in an orderly manner. Copper dusts and Carbamate dusts and sprays (Dithane and Parzate) applied in a definite program paid well this season. It is apparent that late but fairly uniform applications of fungicides prevented the destructive spread of Late Blight until our crop had matured.

For the first time our Dealers, shippers, and growers, really like the Government program. In general, they cooperated with it nearly 100 per cent and probably will in future seasons. The Government purchase of No. 1B size at $2.00 per hundred loaded in cars really did the trick with us. The No. 1 size sold well and the Government worried with the B's. Remember that our growers are used to selling B size for 50 cents per hundred or less and to get $1.44 per hundred helped tremendously. They say this program was less expensive for the Government also. I believe as long as our growers feel that they can plant a fair number of acres and will have some security against prices that will ruin them, they will cooperate with the Government program in every way possible. This program will do a lot to help our growers become better potato farmers. FRANK GARRETT.

INDIANA

Practically all our commercial potato acreage will be planted by the first week in June and our growers are somewhat worried regarding what the Government is going to do. If I remember correctly, approximately 136 acres of potatoes were shipped from Indiana (a deficiency state) to other states and our consumers are not very much in favor of such tactics another year. The intentions to plant will amount to approximately 27,500 acres and unless we have exceptionally high yields we are going to be in need of a lot of potatoes which will naturally keep the wheels rolling on both trucks and railroads.

A few flea beetles are prevalent but they are being controlled in practically all the large fields. The weather has been ideal and so far no disease troubles have appeared. W. B. WARD.

MAINE

Indications are that approximately 97 per cent of Aroostook County Farmers are staying within the acreage allotment. Maine's allotment is 141,300 acres and Aroostook's share is 130,700. Although the County P. and M.A. Committee had a great many requests for increased acreage they were, of course, unable to grant many of these requests, and indications are that there will be a very high participation.

Aroostook got off on an early planting start and for awhile was about two weeks ahead of ordinary conditions. Because of somewhat cold weather and rains in the middle of the month the tempo of work slowed down. Growing conditions indicate that the County is now about one week ahead of average. Farmers, in general, are using more fertilizer and are planting more closely in the row. The average application this year is nearly 2000 pounds of 8-12-16 or equivalent per acre. There seems to be a swing to single strength fertilizers but it is not easy to explain why.

Even though no potatoes have emerged to date, there will be many showing within a day or so. Dr. E. S. Schultz, of the U.S.D.A. has found late blight in some discarded potatoes.

The Extension service is publishing a new Bulletin on the use of DDT. Recommendations are that DDT be applied when one-half of the plants in a field have emerged. Table stock growers who started spraying by the 10th of June can expect control of flee beetles, aphids and also maximum yields if four sprays are applied between the 10th of June and the 15th of August.

The Marketing Agreement for Maine has completed its first year

with appreciably good results according to most potato handlers. VERNE C. BEVERLY.

MISSOURI

The potato crop looks exceptionally well in the Jackson-Clay-Ray district. We have had ideal weather conditions for potatoes with plenty of rain and cool temperatures. The set is perfect and practically every field is showing a good stand.

Late blight developed in several fields during the first part of June. Growers are quite concerned about this disease and are attempting to get the fields dusted between showers. Airplane dusting will be resorted to starting the week of the 5th. Several fields are showing damage from standing water since excessive rain has fallen. At this time (June 4) prospects look good but this picture could change very quickly with continued heavy rains and temperatures favorable for the development of late blight. BEN F. VANCE.

NEW JERSEY

The prolonged dry period which has lasted for 24 days to the present time (June 18) has not only injured early potatoes on the lighter soils but also some of the early varieties on heavier soils. Katahdins and other late varieties are in full bloom and have not been injured as much as have the early varieties. The late-maturing varieties will probably yield a light crop unless adequate rain comes immediately. No estimate of the loss can be determined accurately at present. However, it must be appreciable.

Several growers have purchased irrigation systems during the past two weeks and are irrigating their potatoes continuously. Those growers, who had irrigation systems, have made two to three applications and their potatoes are growing satisfactorily. Irrigation will undoubtedly be of great value this year.

Growers are seriously considering the adoption of a marketing agreement and local meetings have been held throughout the state. We believe that such an agreement, if properly set up and administered, can result in higher prices for high quality potatoes, if the farmers will keep the poor grades off the market and not sell their high quality potatoes too rapidly. JOHN C. CAMPBELL.

NEW YORK

New York growers had about completed their planting operations by the 1st of June, about 10 days ahead of schedule. It is apparent that

our acreage is almost in line with the acreage goals, but at this time it is obvious that we had underplanted rather than overplanted.

Growers in general, have been quite concerned with the Brannan program which they don't like because it puts the emphasis on the non-commercial grower and takes support from the commercial acreage which we like to refer to as the efficient producer. News that this program probably will not be put into effect this year was very welcome.

New York growers are anxious to see the present Support Program given a trial. Potatoes have sold under 60 per cent of Parity only three years in the last 20 years and those years were disastrous as far as potato growers were concerned. Certainly 60 per cent Parity support discourages over planting and speculation.

We think that the present program would help bring supplies in line with demand especially if Marketing Agreements or some other regulation will keep the low grades off the market. H. J. EVANS.

NORTH CAROLINA

Harvesting the new crop of Irish potatoes in eastern North Carolina began the second week in May. The first harvested potatoes began rolling to the market on the 12th of May. At present, practically all of the eastern North Carolina potato growers are in the process of harvesting their crop. The earlier section (around Beaufort) will complete their harvesting operations about the time the later areas (Elizabeth City and Camden) begin digging.

It is expected that an average to above average yield will be obtained from the early crop, as growing conditions have been favorable throughout the season. Growers in most of the areas have been keeping their plants thoroughly dusted with copper fungicides to prevent the development of late blight and to prevent a repetition of the epiphytotic of late blight which occurred during the latter part of the 1948 growing season.

A Field Day was held at The Tidewater Test Farm at Plymouth, N. C., on the 23rd of May. State Commissioner of Agriculture, L. Y. Ballentine, addressed the growers, and the potato research program at the Test Farm was explained by Dr. R. W. Cummings, Associate Director of the North Carolina Experiment Station. A field tour of the experimental plots was conducted by members of the Experiment Station Research Staff. Work that is being conducted on fertilization, varieties, disease control and cultural practices was explained by the staff members during the tour. A larger number of growers were present than was anticipated. This was especially gratifying, since potatoes

were being harvested in many sections and in other areas many growers were preparing to harvest their potato crop.

The 1949 potato acreage for North Carolina is at the quota allotted by the Department of Agriculture. The growers have adhered strictly to their allotted acreages and in no case have there been reports of any grower overplanting his allotment. M. E. GARDNER.

SOUTH CAROLINA

More than 90 per cent of the potatoes from the Charleston-Beaufort area were harvested by the 1st of June. Although not a record-breaking crop it has been one of the best. The average yields are reported running from approximately 100 to as high as 185 bags per acre for the entire farms. Our harvesting operations started about as early as on any previous date and the market demand in addition to good weather speeded the crop to market in record time. The quality has generally been good with some late blight causing trouble in poorly dusted fields. Wireworms, too, are plentiful in a few fields and a trace of soft rot has been observed during the past few days. "Wind cracks" have been reported bad in the few reds planted this year. Viruses were also entirely too evident in the reds which came mostly from North Dakota. More than ½ the crop sold at above $4.00 per bag as washed potatoes, and all potatoes were sold at $3.50 per bag or more. Unwashed potatoes sold for 25-50 cents per bag less and the demand was not so good. Washed Sebagoes have been in demand and sold in northern terminals for as much or more than the Western Longwhites. Trucks moved more of the crop than at any time in the past.

Our growers are now considering the purchasing of more washing machines, and the planting of more Sebagoes next year. This combination apparently makes it possible for our growers to compete favorably with our much-talked-of competition—"California longwhites."

Kennebec has performed well in the Station Trials for several seasons and it is hoped that seed will be available for extensive grower and shipper trials next year. W. C. BARNES.

SOUTH DAKOTA

Early-planted potatoes in South Dakota are up and show a good stand. There will be approximately a 12 per cent reduction in the potato acreage in this area and we expect about 6500 acres to be entered for certification. The acreage of all potatoes in South Dakota will be about 18,000 this year which will be the smallest acreage since 1884.

Field inspection will start about the 15th of June and Dr. C. E. Rosenquist from the University of Nebraska will work on field inspection with Dr. L. T. Richardson from the University of Ottawa, Canada, who is coming to South Dakota State College as Assistant Pathologist with the Experiment Station.

Not much comment has been heard concerning the support program for the 1949 crop but growers believe the purchase of only Number 2 potatoes is a step in the right direction.

The appointment of members of the Marketing Committee has been announced and they will meet after the 1st of July to organize for the year.

Shipments of the 1948 crop under commercial grade were restricted by the Marketing Order. A total of 929,002 cwt. was inspected during the 1948 crop season of which 58.4 per cent were U. S. No. 1 quality, 7.7 per cent were U. S. commercial grade, and 15.8 per cent were U. S. No. 2 grade.

Certified seed potato shipments amounted to 13.8 per cent of the crop in 1948. JOHN NOONAN.

PROVINCE OF CANADA

As your paper goes to press, Prince Edward Island is just completing the marketing of last year's crop. The surplus of approximately 500 carloads has been purchased by the Agricultural Price Support Board.

During the last week of May our domestic market, becoming depleted with potatoes, rose sharply.

Planting in Prince Edward Island as of the 1st of June was 25 per cent completed and the acreage will possibly be down at least 10 per cent of last year.

Again this year all growers are required to plant certified seed or even better seed if obtainable. Also the usual attention is being paid to seed plots with tuber unit planting and a considerable number of seed plots are using seed which has been eye-indexed by the local Inspection Service under the supervision of Mr. S. G. Peppin. E. D. REID.

AMERICAN POTATO YEARBOOK

The 1949 edition of the AMERICAN POTATO YEARBOOK is off the press. The new volume is considerably larger than last year's issue and contains eighty-four pages of interesting and vital information to the potato grower, the potato dealer and shipper, the potato research specialist and all those with an interest in the potato industry. It is

edited by John C. Campbell, Rutgers University College of Agriculture and is endorsed by the Potato Association of America.

Of special significance is the feature article by Dr. F. J. Stevenson of the United States Department of Agriculture on past, present, and future varieties of potatoes. The article is illustrated with tables. There is also an up-to-date list of more than 100 references to potato culture in the United States. Other interesting items include rules and regulations affecting the shipment of seed potatoes, support schedules, a map indicating the leading potato areas in this country, a list of leading United States and Canadian associations engaged in the improvement of the potato industry together with the names of United States and Canadian seed certification officials. The YEARBOOK also gives information on how and where to secure helpful brochures and leaflets covering many phases of the potato industry.

The book contains much statistical information of value. There are tabulations by states of both seed and table stock production as well as statistics on Canadian and world potato production. Other important features include an illustrated chart indicating the utilization of white potatoes, a list of periodicals of interest to the potato industry, a chart giving the amount of seed required and a classified directory of business concerns serving growers and dealers.

Copies of the YEARBOOK may be secured from the American Potato Yearbook, Business Office, 289 Fourth Avenue, New York 10, N. Y. An individual copy sells for $2.00.

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THE INFLUENCE OF IRRIGATION ON THE NITROGEN, PHOSPHOROUS AND POTASH REQUIREMENTS OF DIFFERENT POTATO VARIETIES[1]

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(Accepted for publication, Mar. 23, 1949)

The extensive use of overhead irrigation on Long Island has led to a need for a re-examination of the various fertilizer recommendations. In 1946 a factorial experiment was begun to study three levels each of nitroge, phosphorous and potash in all combinations. These fertilizer levels were applied to four varieties of potatoes with and without irrigation. From the results of this experiment over a period of years it is hoped that adequate levels of fertilization can be determined for the major varieties of potatoes grown on irrigated farms as well as potatoes grown on farms without irrigation.

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*Refers to literature cited at end of paper.

This report is a summary of three years' results from this factorial experiment in which six varieties of potatoes have been grown.

Material and Methods

Three levels of nitrogen, 40, 80 and 120 lbs. N per acre, three levels of phosphorous, 80, 160 and 240 lbs. P_2O_5 per acre and three levels of potash, 40, 80 and 120 lbs. K_2O per acre were utilized in all combinations giving 27 fertilizer treatments. Each of two blocks was split in two, one-half receiving irrigation to provide a minimum of one inch of water per week and the other one-half receiving no water except normal rainfall. These four irrigation plots were split in 1946 into 4 plots each planted to different variety of potato. On each variety 27 plots 28 feet long and 3 rows wide were provided for the various fertilizer treatments. Thus there were 216 treatment combinations represented in two blocks.

In 1947 the experimental design was changed somewhat so that the plots were 28 feet long and 4 rows wide. Three varieties were grown and the varieties and fertilizer treatments were arranged on each irrigation plot in a 9x9 half plaid Latin square as described in detail in (1)* This same design was used in 1948 and the plots were located at the same places each year.

Varieties grown each year were as follows: 1946 Green Mountain, Mohawk, Katahdin and Sequoia; 1947 Green Mountain, Mohawk and Ontario; and 1948 Green Mountain, Katahdin and Cobbler.

Only certified seed was used and normal cultural practices were followed. Irrigation was applied twice in 1946, six times in 1947 and four times in 1948. The amounts of rainfall and irrigation for each year are given in table 1.

The fertilizer was applied in bands with an Iron Age planter modified for use in factorial experiments as described by Wessels (3). All varieties were planted on the same day and the planting dates were the 12th of April, 1946; the 16th of April, 1947; and the 21st of April, 1948. All varieties were killed on the 24th of August, 1946, the 8th of September, 1947, and the 28th of August, 1948. At these times all varieties were mature and the vines were killed to prevent second growth and to control the growth of crabgrass.

All data were subjected to the analysis of variance procedures for split plot and factorial designs. A complete description of the method is given by Jacob (1). The significant components of the interactions were determined by an extension of the method described by Kemp (2).

TABLE 1.—*Rainfall from planting to maturity by weeks after planting date and time and amount of water added by irrigation.*

(All figures are inches of water)

Week after Planting	Rainfall 1946	Rainfall 1947	Rainfall 1948	Irrigation 1946	Irrigation 1947	Irrigation 1948
1	0.07	0.46	0.36			
2	0.97	0.86	1.71			
3	0.05	1.59	0.92			
4	0.54*	0.24*	1.49*			
5	2.42	1.31	0.72			
6	0.49	0.32	1.69			
7	1.14	0.70	0.27			
8	2.98	0.79	1.86		1.00	
9	0.50	0.44	1.63		0.60	
10	0.14	1.74	0.07			
11	0.00	0.00	0.86	1.00	1.00	
12	1.33	0.81	1.02			1.00
13	0.07	0.81	1.03	0.70		
14	0.01	0.95	0.35		0.40	
15	1.97	0.14	0.79		0.90	0.85
16	0.88	0.79	0.17			0.80
17	6.91	0.03	0.00		0.75	1.00
18	1.74	2.19	0.00			
19	2.36	0.75				
20	0.88	0.19				
21	0.21	0.03				
22	0.00					
23	0.02					
Total	25.68	15.14	14.94	1.70	4.65	3.65
Ave. per Wk.	1.12	0.72	0.83	0.07	0.22	0.20

*Time plants emerged from ground.

RESULTS AND DISCUSSION

The year 1946 was an exceedingly favorable one for potatoes since moisture was abundant and quite well distributed, as can be seen in table 1. Consequently only twice was extra moisture in the form of irrigation considered necessary. In 1947, however, six applications were made during July and August. The early part of the 1948 season was quite wet, whereas the months of July and August were very much lacking in rainfall. These weather observations should be kept in mind when considering the results from the various years' work.

1946 EXPERIMENT

Since the percentage of potatoes in 1946 which were not U. S. No. 1 was so small, only total yields will be considered. Because of the

complex nature of the experiment the interpretation of the results will be accomplished by small main effect tables, and graphs will be used in interpreting interactions.

The analysis of variance for the 1946 data indicates that varieties differ significantly, and a very large variance is associated with nitrogen also. Although potash and the nitrogen x irrigation interaction are significantly greater than the error term, they do not differ significantly from the two significant third order interactions NKIV and PKIV. Thus they will not be discussed separately.

The average yields of the varieties are given in table 2. Further analysis confirms the observation that Katahdin and Green Mountain do not differ from one another, nor does Mohawk differ from Sequoia, but the first two average significantly higher in yield than do the latter two.

TABLE 2.—*Average total yield of different varieties over all other treatments*—1946.

Variety	Yield in Bushels per Acre
Katahdin	404
Green Mountain	374
Mohawk	347
Sequoia	334

There was a significant linear response to nitrogen on the average of all varieties (table 3). The increase in yield obtained by using 80 pounds of N compared to 40 pounds of N was not significantly different from the increase found by applying 120 pounds of N compared to 80 pounds.

TABLE 3.—*Average yields obtained from the various levels of nitrogen*—1946.

Levels of N.	Yield in Bushels per Acre
40 lbs/acre	327
80 lbs/acre	371
120 lbs/acre	396

The influence of irrigation on the nitrogen response of the different varieties at varying levels of potash is shown in figure 1. Without irrigation Katahdin responded to high nitrogen at medium potash level but not at high potash, whereas with irrigation it was necessary to provide high potash to obtain a response to high nitrogen from Katahdin. The other three varieties showed little response to high nitrogen at either level of potash without irrigation, but with irrigation they responded best to high nitrogen at the medium level of potash. At the

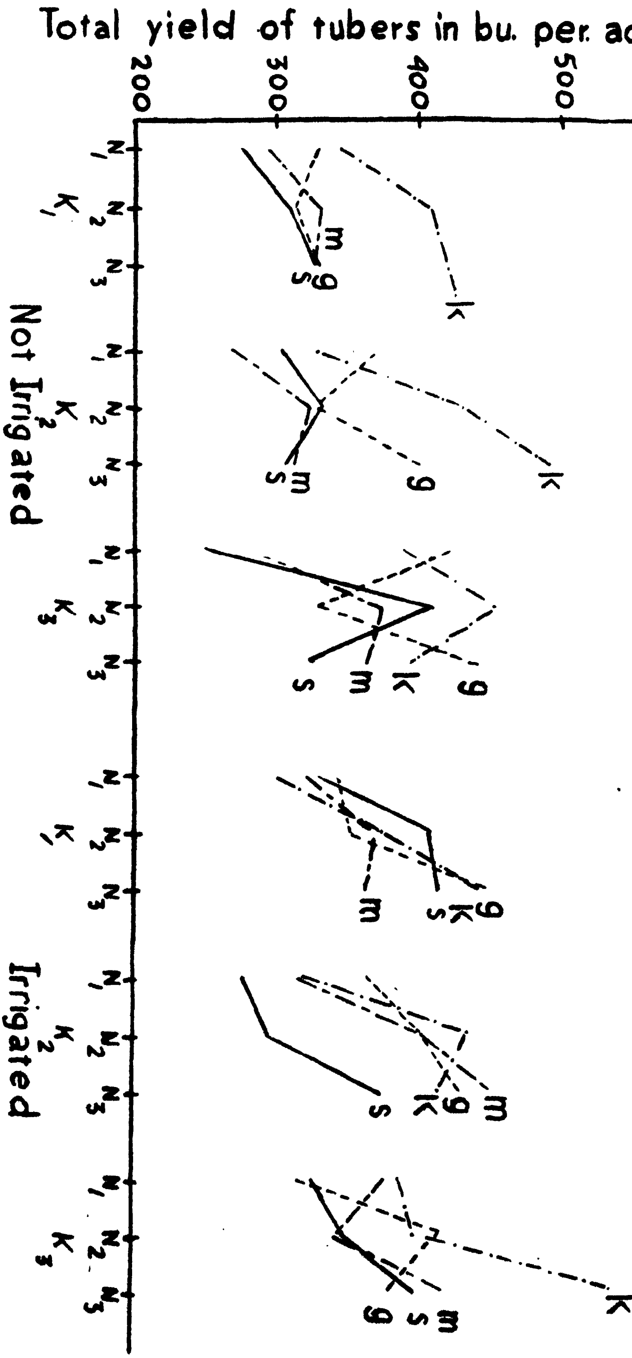

Figure I. Influence of irrigation on the response of different potato varieties to nitrogen at varying levels of potash-1946

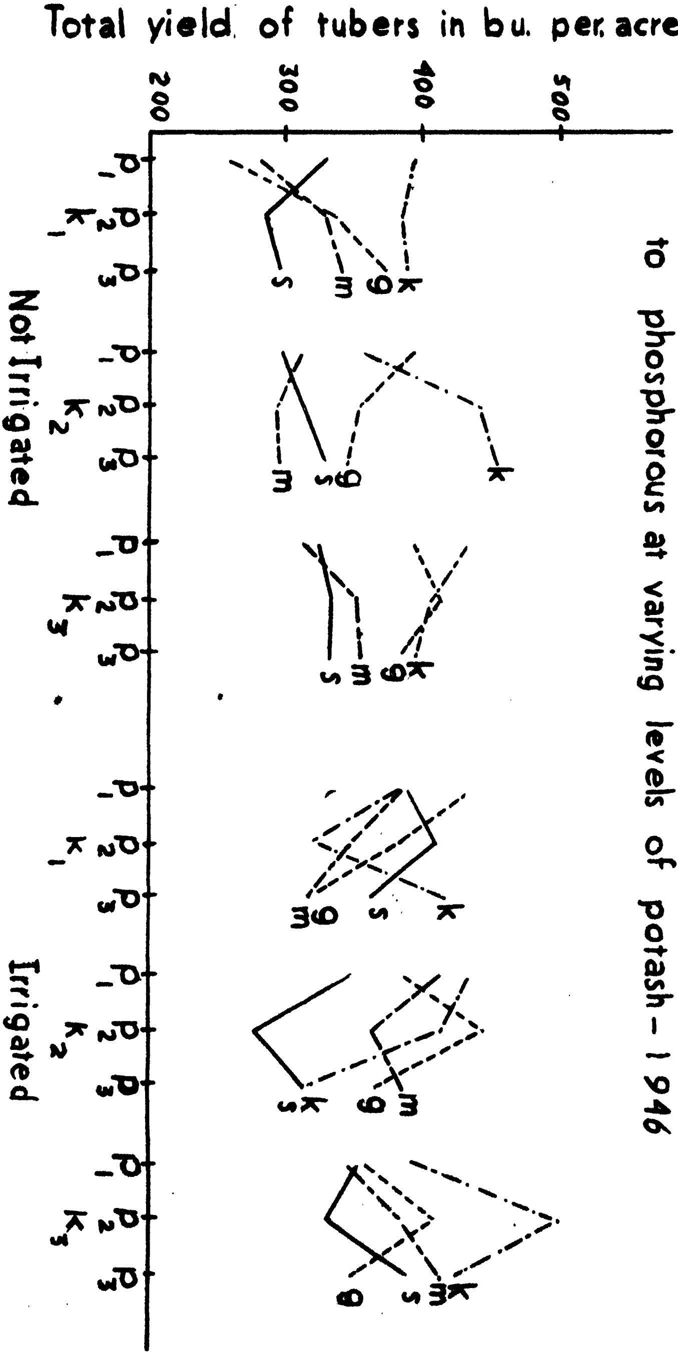

Figure 2.—Influence of irrigation on the response of different varieties to phosphorous at varying levels of potash—1946

low level of potash the nitrogen response curves of the varieties were not influenced by irrigation differently from the other two potash levels.

There was a significant influence of irrigation on the differences between the phosphorous response curves of the varieties at varying levels of potash. Without irrigation at low potash Green Mountain responded well to phosphorous, but Katahdin did not; whereas with irrigation Green Mountain was actually depressed by increased phosphorous, and Katahdin showed some benefit from large amounts. At medium potash without irrigation Green Mountain was depressed by additional phosphorous whereas Katahdin showed a benefit, but with irrigation Katahdin was depressed more markedly than was Green Mountain. At high potash the responses of both varieties were influenced the same by irrigation. Sequoia also exhibited some different effects of irrigation in the phosphorous response curves at low and medium potash compared with Green Mountain. Without irrigation at low potash, Sequoia did not respond to phosphorous, whereas Green Mountain did. At medium potash Sequoia did respond slightly to phosphorous, but Green Mountain was depressed. With irrigation and low potash both varieties were depressed by high phosphorous; Green Mountain more so than Sequoia. At medium potash the intermediate phosphorous increased Green Mountain and decreased Sequoia yields, whereas high phosphorous reversed this response (Figure 2.).

To summarize these results, without irrigation Katahdin responded best to high nitrogen and high phosphorous at the medium potash level. With irrigation the best response to high nitrogen and medium phosphorous was at high potash. In 1946, unirrigated Katahdins seemed to need 120 lbs. N, 160 lbs. P_2O_5, and 80 lbs. K_2O, but with irrigation 120 lbs. N, 160 lbs P_2O_5 and 120 lbs. K_2O constituted the best ratio.

Green Mountain responded poorly to high nitrogen without irrigation but under these conditions the best yields were obtained in the presence of high potash. With high potash, however, Green Mountain was depressed by high phosphorous. When irrigated, Green Mountain responded best to additional nitrogen at the low level of potash, and was depressed by high phosphorous at all levels of potash. Thus without irrigation Green Mountain seemed to need 120 lbs. N; 160 lbs. P_2O_5; and 120 lbs. K_2O, but with irrigation 120 lbs. N; 80 lbs. P_2O_5; and 40 lbs. K_2O were sufficient. Mohawk responded poorly to nitrogen in excess of 80 lbs. except with irrigation at medium potash. A phosphorous response was obtained without irrigation at low and high potash and with irrigation at high potash. Thus without irrigation, Mohawk seemed to need 80 lbs. N; 160 lbs. P_2O_5; and 120 lbs. K_2O, but with

irrigation 120 lbs. N; 80 lbs. P_2O_5; and 80 lbs. K_2O was the best treatment.

Sequoia responded best to 80 lbs. nitrogen at high potash without irrigation and to 120 lbs. of nitrogen at high potash with irrigation. There was little response to phosphorous, although high phosphorous was less effective at lower levels of potash. The needs of Sequoia without irrigation were 80 lbs. N; 80 lbs. P_2O_5; and 120 lbs. K_2O; but with irrigation 120 lbs. N; 240 lbs. P_2O_5; and 120 lbs. K_2O were required.

1947 Experiment

Because of the improvement in design the C. V. for 1947 was 10 per cent compared to 22 per cent for 1946. Thus many more significant differences are observed in the analysis of variance table.

All three varieties differed significantly from one another (table 4). Ontario yielded 23 bushels per acre more than Green Mountain and Green Mountain outyielded Mohawk by 73 bushels per acre. There was a significant increase in yield when nitrogen was added (table 5). However, the increase from 80 lbs. to 120 lbs. of nitrogen per acre was significantly less than the increase from 40 lbs. to 80 lbs. nitrogen per acre. Phosphorous also increased yields when raised from 80 lbs. to 160 lbs. P_2O_5 per acre, but additional phosphorous was not effective in increasing yields (table 9).

Table 4.—*Average U. S. No. 1 yields of different varieties over all other treatments*—1947.

Variety	Yield in Bushels per Acre U. S. No. 1
Ontario	388
Green Mountain	365
Mohawk	292

The influence of potash on the varietal response to phosphorous is shown in figure 3. At low potash Ontario responded to phosphorous applications. At high levels of potash no response was obtained. Mohawk responded to 160 lbs. P_2O_5, but not to any additional P_2O_5 and the maximum response was at high potash. Green Mountain failed to respond to phosphorous applications at any level of potash, and at a low level of potash high phosphorous actually decreased yields.

The influence of irrigation on the nitrogen response of the varieties at different levels of potash is shown in figure 4. Without irrigation Green Mountain responded to high nitrogen only at low potash, but with irrigation the maximum response to nitrogen by Green Mountain was at medium potash, athough there was a good response at high potash also. Ontario only responded to high nitrogen at high potash with-

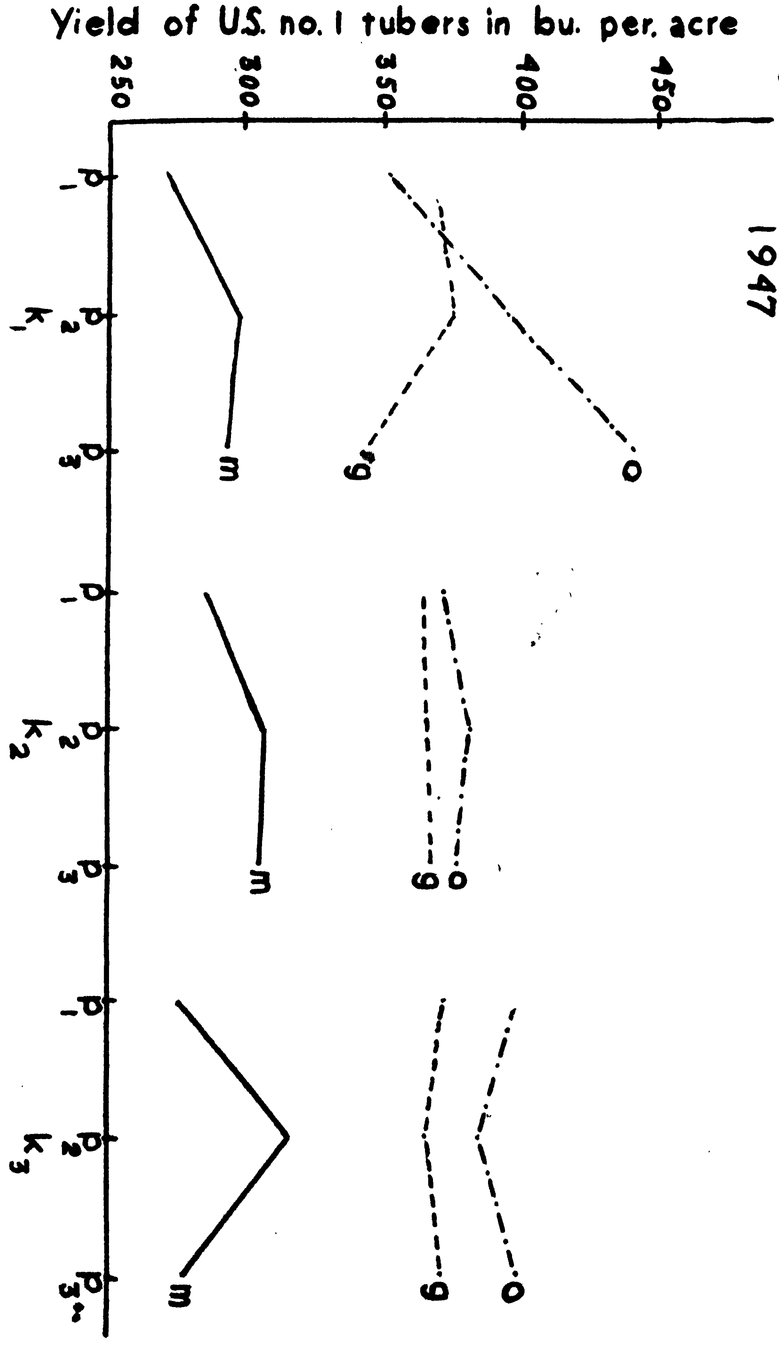

Figure 3. Influence of potash on the varietal response to phosphorous—1947

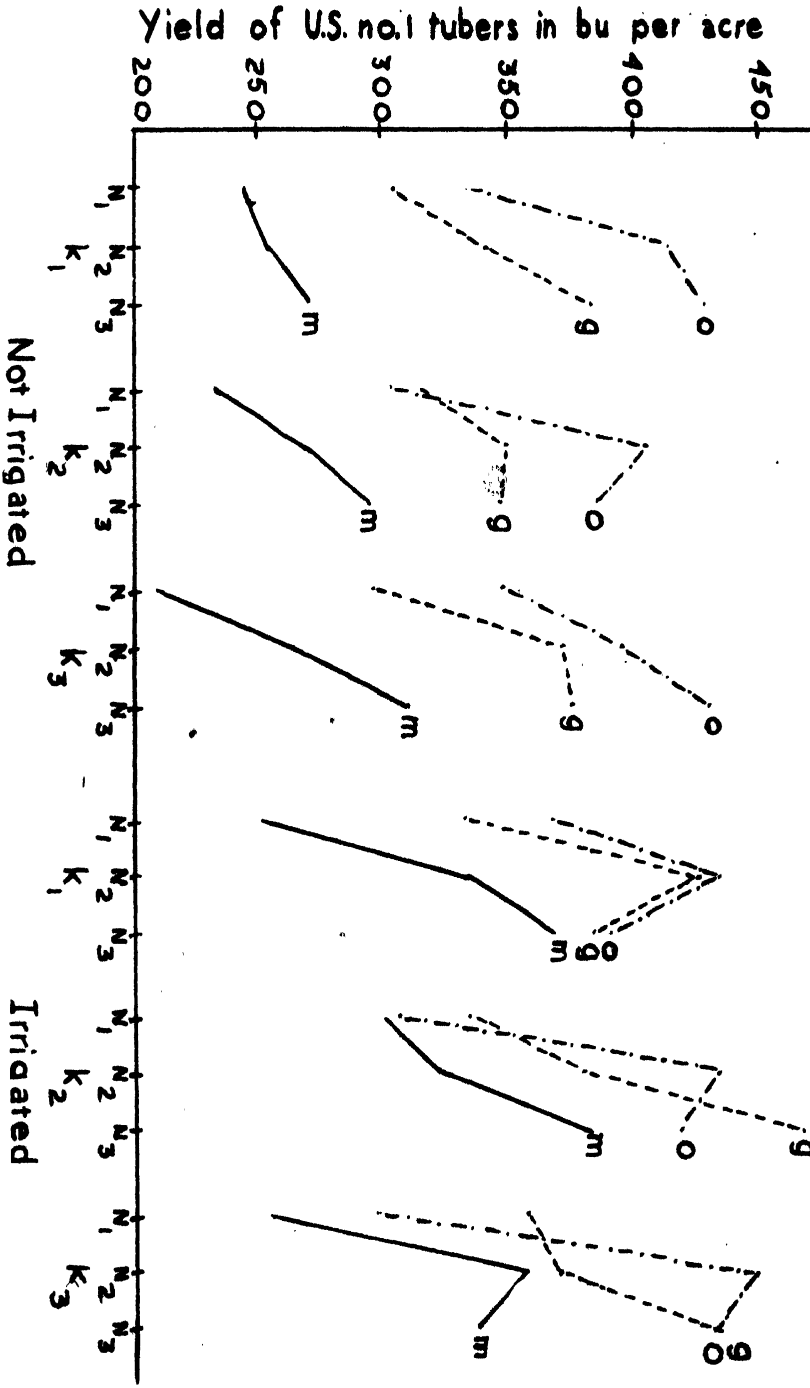

Figure 4.—Influence of irrigation on the response of different varieties to nitrogen at varying levels of potash—1947

out irrigation, and with irrigation there was a good response to medium nitrogen at high potash. Without irrigation Mohawk responded best to high nitrogen at high potash, but with irrigation the best response to nitrogen was at medium potash.

TABLE 5.—*Average U. S. No. 1 yields obtained from various levels of nitrogen*—1947.

Levels of N.	Yield in Bushels per Acre U. S. No. 1
40 lbs./acre	300
80 lbs./acre	366
120 lbs./acre	380

To summarize these results, Ontario responded best to high nitrogen at high potash and also did well at low potash without irrigation, whereas the only response to phosphorous was at low potash. With irrigation 80 lbs. of nitrogen were sufficient at any level of potash. Thus without irrigation Ontario seemed to need 120 lbs. N; 240 lbs. P_2O_5; and 40 lbs. K_2O and with irrigation 80 lbs. N; 240 lbs. P_2O_5; and 40 lbs. K_2O. Green Mountain responded to high nitrogen at low potash without irrigation and with irrigation the best response was obtained at medium potash. There was no response to phosphorous. Thus for Green Mountains without irrigation the needs were 120 lbs. N; 160 lbs. P_2O_5; and 120 medium potash. There was no response to phorphorous. Thus, for Green Mountains without irrigation the needs were 120 lbs. N; 80 lbs. P_2O_5, and 40 lbs. K_2O and with irrigation 120 lbs. N; 80 lbs. P_2O_5; and 80 lbs. K_2O.

TABLE 6.—*Average U. S. No. 1 yields obtained from various levels of phosphorous*—1947.

Levels of Phosphorous P_2O_5	U. S. No. 1 Yield in Bushels per Acre
80 lbs./acre	339
160 lbs./acre	354
240 lbs./acre	352

Mohawk responded well to high nitrogen at high potash without irrigation and to high nitrogen at medium potash with irrigation. There was no phosphorous response above 160 lbs. P_2O_5. Thus for Mohawk without irrigation the needs were 120 lbs. N; 160 lbs. P_2O_5; and 120 lbs. K_2O; and with irrigation 120 lbs. N; 160 lbs. P_2O_5; and 80 lbs. K_2O.

1948 Experiment

The yields were considerably lower than corresponding yields in 1947. In table 1, it can be seen that 1948 was quite wet before emergence time and as a result considerable leaching of fertilizers took place. The latter part of the season was hot and dry so the crop matured earlier than in 1946 or 1947. The analysis of variance for the yield data showed that the error variance was low and small difference would be detected. The marked effect of nitrogen (table 7) is due in part to the heavy leaching rains early in the season, with 120 lbs. of nitrogen per acre giving a significant increase in yield over 80 lbs.

Table 7.—*Average U. S. No. 1 yields obtained from various levels of nitrogen*—1948.

Levels of Nitrogen	U. S. No. 1 Yield in Bushels per Acre
40 lbs./acre	190
80 lbs./acre	274
120 lbs./acre	307

In spite of the wet season the late application of irrigation had a significant influence on the varietal response to nitrogen at different levels of potash as shown in figure 5. Green Mountain responded to high nitrogen best at low potash without irrigation, but with irrigation the response was best at medium potash. Katahdin responded to high nitrogen at high potash without irrigation, but with irrigation the best response was obtained with low potash. Cobbler responded to high nitrogen at high potash without irrigation and with irrigation the response was the same.

There was also an influence of irrigation in the varietal response to phosphorous at different potash levels as you will note in figure 6. Cobbler responded to phosphorous at low potash with or without irrigation, but high phosphorous was best with irrigation. At other levels of potash the response was varied. Green Mountain showed no response to phosphorous except at medium potash with irrigation. Katahdin also showed best response to phosphorous at medium potash with irrigation.

In summary, without irrigation, Green Mountain responded to high nitrogen at low potash, and at this potash level there was no response to phosphorous. With irrigation the best nitrogen response was with medium potash and this level also gave some response to phosphorous. Without irrigation Green Mountain seemed to need 120 lbs. N; 80 lbs. P_2O_5; and 40 lbs. K_2O, but with irrigation 120 lbs. N; 240 lbs. P_2O_5; and 80 lbs. K_2O proved to be the best ratio.

Without irrigation Katahdin responded to nitrogen at high potash,

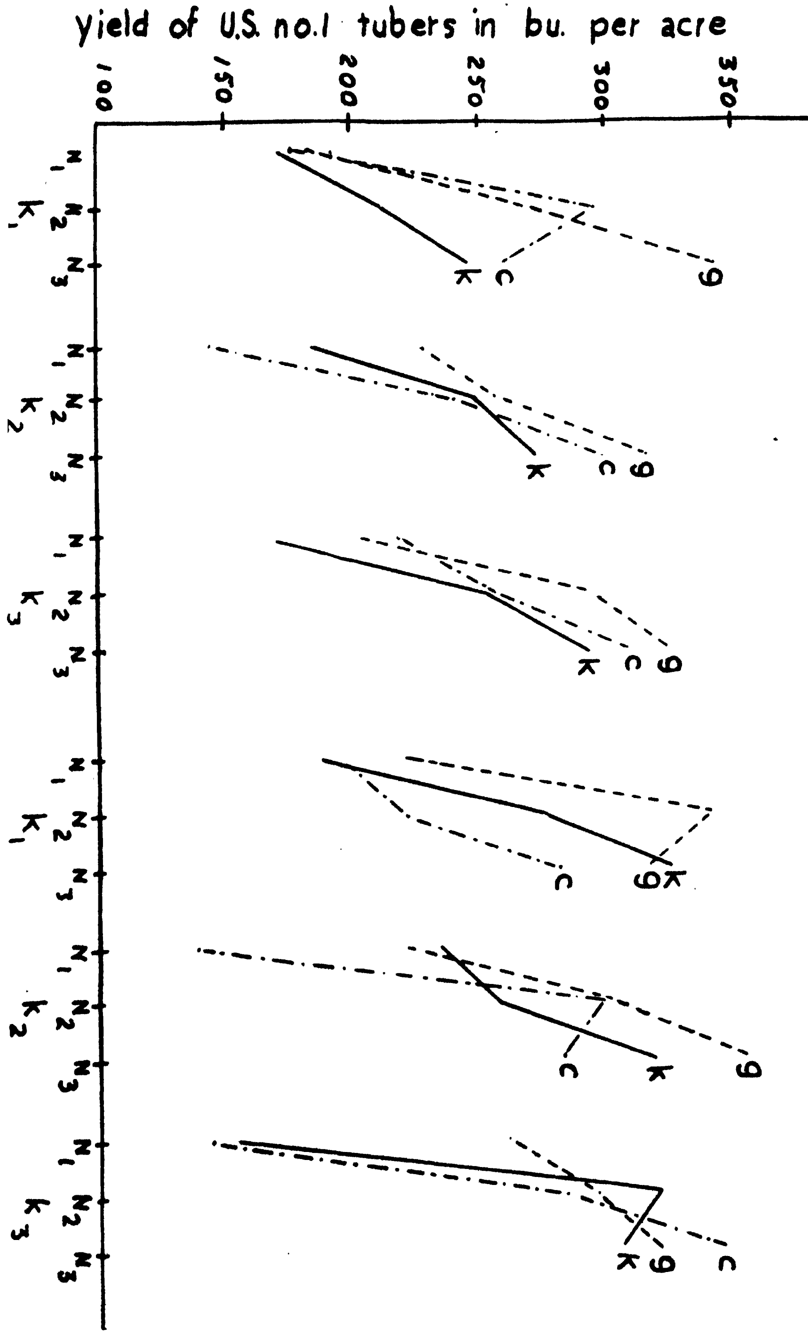

Figure 5. Influence of irrigation on the response of different varieties to nitrogen at different levels of potash- 1948

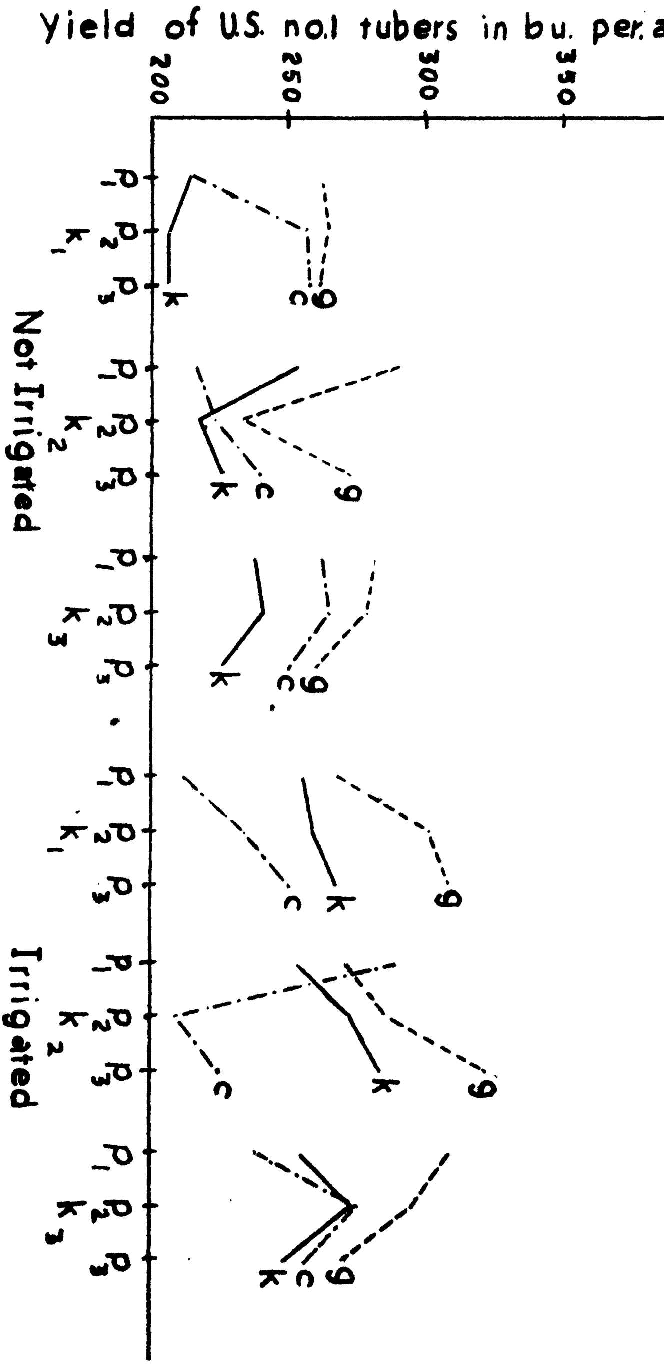

Figure 6. Influence of irrigation on the response of different varieties to phosphorous at different levels of potash–1948

and at this potash level low phosphorous was best. With irrigation the best response to nitrogen was at low potash, and at this potash level phosphorous showed very little influence. The needs for Katahdin without irrigation were 120 lbs. N; 80 lbs. P_2O_5; and 120 lbs. K_2O, but with irrigation 120 lbs. N; 80 lbs. P_2O_5; and 40 lbs. K_2O were adequate.

Cobblers without irrigation responded to high nitrogen at high potash, and at this potash level, low phosphorous was best. With irrigation high potash gave the best nitrogen response, and medium phosphorous was best here. Thus for Cobbler, the needs without irrigation were 120 lbs. N; 80 lbs. P_2O_5; and 120 lbs. K_2O but with irrigation 120 lbs. N; 160 lbs. P_2O_5; and 120 lbs. K_2O gave the best yield.

It should be pointed out that more than 120 lbs. of nitrogen seemed to be needed in some cases and in the future this change will be made. Some lowering of the phosphorous levels is indicated as well as a wider spread for potash.

Summary

1. Three years' results are reported for a 3N, 3P, 3K factorial fertilizer experiment with and without irrigation, in which 3 or 4 varieties of potatoes were grown each year.

2. Green Mountain variety was grown each year and the three years indicated a need for more than 120 lbs. of nitrogen, providing the phosphorous level is kept below 160 lbs. P_2O_5 and potash is at a low to medium level. Without irrigation about 2000 lbs. of a 6-4-2 seemed best, but with irrigation 2000 lbs. of a 66-4-4 appeared best.

3. Katahdin was grown two years. Without irrigation about 2000 lbs. of a 6-4-6 and with irrigation 2000 lbs. of a 6-4-2 were best.

4. Mohawk was tested two years. Without irrigation about 2000 lbs of a 6-8-6 and with irrigation 2000 lbs. of a 6-8-4 was best.

5. Sequoia in 1946 without irrigation did best on a ton of 4-4-6, but with irrigation a ton of 6-12-6 was best.

6. Ontario in 1947 without irrigation needed a ton of 6-12-2 and with irrigation a ton of 4-12-2.

7. Cobblers in 1948 without irrigation needed a ton of 6-4-6 and with irrigation a ton of 6-8-6.

8. Results indicated a need for changes in the levels of the N, P, and K factors for the future conduct of this experiment.

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THE EFFECT OF ZINC-CONTAINING DUSTS AND SPRAYS ON THE YIELD OF POTATOES[1]

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Potatoes are one of the many species of plants responding to the application of zinc. Extensive and carefully conducted water culture experiments by Schreven (12) showed that potato plants deprived of zinc were stunted and had necrotic spots on the leaflets. In severe cases local necrosis was present on the petioles and stems, and in 2 instances terminal necrosis developed. The response of potatoes to zinc-containing fertilizers has not been too favorable. Experiments by Morgan (9) in Western Australia were made to ascertain whether any effect was derived from the inclusion of certain minor elements, including zinc, in the fertilizer mixtures. His results showed that no benefit was derived as measured by yield. Rost, Kramer and McCall (11) conducted extensive potato fertilizer experiments over a period of 4 years on 40 farms located in 12 communities of the Red River Valley of Minnesota. In 1939 elaborate trials with the minor elements boron, zinc, manganese and copper were performed on 11 fields and these were repeated on one field in 1942. The treatments included the minor elements singly and in combination with all fertilizer treatments. The use of any of these minor elements either alone or in combination with fertilizer failed to increase the yield significantly. More recent research in Maine (13) compared the effect of fertilizer containing none or only trace amounts of zinc with fertilizer containing 20 pounds of zinc sulphate per acre. In 2 of the 4 experiments the potatoes yielded the same whether fertilized with zinc sulphate or not. In the remaining 2 tests zinc sulphate increased the yield by 12 bushels per acre in both experiments. In one of these tests, zinc increased yields an average of 32 bushels on the plots cropped every year to potatoes; 11 bushels on plots where potatoes were grown in alternate years with crimson clover, and only 2 bushels on plots in a similar rotation with millet.

Extensive research in certain western citrus-producing areas has demonstrated an effective method of supplying zinc to zinc-deficient

[1]Commercial grants were received from the Agricultural Supply Company, Grand Forks, North Dakota, the Rohm and Haas Company and the Tennessee Corporation.

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trees was to apply zinc-containing sprays to the leaves. Although Ellis (5) did not report zinc-deficiency symptoms on potatoes grown on Indiana muck soil, he obtained significantly higher yields in 3 of the 4 years by adding zinc sulphate to the regular copper-lime spray. He noticed that the addition of zinc sulphate to the spray imparted a bluish-green cast to the foliage and suggested that the zinc either stimulated growth or satisfied a minor element deficiency, although zinc sulphate applied to this soil had never increased yields. After using some of the new organic fungicides, Ellis (6) has recently reported that higher yields may be expected from potatoes sprayed with the zinc-containing materials Dithane D-14, Dithane Z-78 and Parzate than from those sprayed with copper fungicides, even though the degree of disease control may be the same. Somewhat similar results have been reported by Berkeley, Thompson and Richardson (1, 2) from Ontario, Canada. The addition of zinc sulphate and lime to Copper Oxychloride Sulphate, Copper-A Compound and Fermate resulted in larger yields than when these materials were used alone. A favorable response was obtained by the Rhode Island Agricultural Experiment Station (10) when cut seed pieces were dipped for 30 seconds in a solution of the zinc-containing fungicide Zerlate. Zerlate-treated seed pieces emerged earlier than those treated with 4 other materials, not containing zinc, or the check and yielded 34 bushels per acre over the check.

There are numerous conflicting reports by potato growers, research workers and others regarding the influence of various potato fungicides on yield. Hypotheses attempting to explain these yield differences have also been advanced. After 3 year's research with Bordeaux Mixture and certain new organic fungicides in Connecticut, Horsfall and Turner (8) suggested that dithiocarbamates, particularly Dithane, were not much if any better than Bordeaux Mixture in the control of late blight, but they did permit the potatoes to set a larger yield. They suggested that this was due to a lower level of phytoxicity which, in turn, was caused by a low lime content of the Dithane. Although the lime may have had some influence, it is possible that the zinc in the organic fungicides they tested was a contributing factor to the increased yields. In a recent report from Connecticut (4), Dithane- and Parzate-sprayed plots were the highest yielding of the 7 materials tested and Bordeaux Mixture, the only fungicide containing lime, ranked third. These yields were obtained during the absence of late blight and early blight. In Delaware, it is Heuberger's (7) opinion that the increased yields obtained through the use of zinc ethylene bisdithiocarbamate sprays, as well as by Zerlate when late blight is not present,

are due mainly to the fact that these fungicides are not as phytotoxic as the copper fungicides in common use.

The summaries of the National Cooperative Potato Spray Fungicide Experiments for 1947 (3) and 1948 (4) included the extensive investigations of several potato-growing states in the Midwest and East, and may be regarded as significant information with respect to the influence of some of the newer materials on yield. In 1947, plots sprayed with Dithane D-14, Parzate and Zerlate produced the highest yields in 9 states reporting no late blight. Five of the 14 cooperating states in 1948 reported no late blight and little or no early blight. A summary of the results from these 5 states showed that plots sprayed with Dithane D-14 yielded the highest followed by Parzate and Zerlate. Another zinc-containing fungicide, Copper-Zinc Chromate, ranked fourth in yield. Plots treated with Tri-Basic Copper Sulphate, Bordeaux Mixture and Copper Oxychloride Sulphate ranked fifth, sixth and seventh respectively.

The potato fungicide experiments reported in this paper were conducted at different locations in the Red River Valley of North Dakota during each of the years 1946, 1947 and 1948. Early blight, *Alternaria solani,* was absent in 1946 and first appeared on the 1947 plots on the 19th of August. The infection varied from slight to moderate on the variously treated plots at the time of the first killing frost on the 21st of September. It was not present in sufficient amount during 1948 to determine the effectiveness of the various fungicides. Late blight, *Phytophthora infestans,* appeared as a trace in 1948 and was absent the other 2 years. Under these conditions it was possible to determine the effect of the various materials applied as dusts and sprays. Zinc deficiency symptoms were never observed on the vines during this investigation and have never been reported on any crop grown in the Red River Valley of North Dakota.

Experimental Procedure and Results

Information regarding the experimental procedure is shown in table 1. Of significance was the fact that the triple lattice design was more efficient during each of the 3 years than the randomized block. Omitted from the table are climatological data at each of the 3 locations. In 1946 the soil was low in moisture during planting and remained thus until the 24th of June when 0.70 inches of rainfall was recorded. Lack of sufficient moisture during the entire growing season was the principal reason causing the low yields. The growing seasons of 1947 and 1948 were favorable for potatoes.

The common potato insects present in the Red River Valley of North Dakota are the Colorado potato beetle, *Leptinotarsa decemlineata*, the potato flea beetle, *Epitrix cucumeris*, the potato leafhopper, *Empoasca fabae*, and the 6-spotted leafhopper, *Macrosteles divisus*. To reduce the injury caused by them, DDT was used alone on certain plots and included with each fungicide. During 1946 and 1947 the tractor and attached sprayer were driven over the no-treatment plots at the time of each application in order to compensate for vine injury on the treated plots.

From the yields given in table 2 for 1946 it is evident that plots sprayed with Dithane D-14, Parzate and Dithane Z-78 were the only treatments having significant yields when compared with plot 31 which received no treatment. When compared with plot 1, receiving only 5 per cent DDT, the differences were not significant. It is of interest, however, that the 3 highest-yielding plots were sprayed with zinc-containing fungicides. Bordeaux Mixture ranked fourth and lacked 0.1 bushel of being significant at the 5 per cent level.

Further evidence supporting the preliminary 1946 results was obtained in 1947. Plot 3 was dusted with Zerlate and had a highly significant yield when compared with the plots receiving 5 per cent DDT or no treatment. The yield from the Dithane Z-78 treatment was not significant but higher than plots dusted with Copper-A Compound or Tri-Basic Copper Sulphate. Plots sprayed with Dithane D-14 and Zerlate were significantly higher than the no-treatment plot but not plot 1 which received 5 per cent DDT. A comparison of the yields obtained from plots 10 and 15 indicated that the number and time of Zerlate applications had an effect when the degree of early-blight control was the same. Plot 10 received Zerlate during the last 3 applications, and yielded 259.4 bushels or 24.7 bushels less than plot 15 which received 6 applications.

The most significant results were obtained in 1948 using Irish Cobblers fertilized with a 4-12-8 fertilizer at 440 pounds per acre. Among the 6 dust treatments, only the zinc-containing materials Zerlate, Dithane Z-78 and Parzate produced significant yields; the latter being highly significant. Six plots received fungicidal sprays and the 5 containing zinc had significant yields at the 1 per cent level. The sixth, Tri-Basic Copper Sulphate, only yielded 5.6 bushels more than the plot receiving 5 per cent DDT. In order to determine the effect of zinc sulphate alone, plots 19, 20 and 21 received this minor-element-containing chemical at different times during the season. The yield from each of the 3 plots was highly significant and comparable to some

TABLE 1.—*Details regarding the experimental procedure.*

	1946	1947	1948
Location	Grafton	Grand Forks	Northwood
Soil classification	Bearden silty clay	Bearden silt loam	Bearden very fine sandy loam
Variety	Bliss Triumph	Bliss Triumph	Irish Cobbler
Planting dates	May 21 & 22	May 14 & 15	June 10
Fertilizer and rate per acre	None	None	4-12-8 at 440 lbs.
Plot design	Triple lattice	Triple lattice	Triple lattice
Efficiency of triple lattice compared with randomized block	201 per cent	155 per cent	138 per cent
Number of treatments	16	16	16
Number of replications	6	6	6
Size of plots	2 rows wide, 80 ft. long, 2 untreated rows on each side	2 rows wide, 80 ft. long, 2 untreated rows on each side	2 rows wide, 80 ft. long, 2 untreated rows on each side
Row width	36 in.	36 in.	38 in.
Duster	2-row, tractor-mounted Niagara, 3 nozzles per row	2-row, tractor-mounted Niagara, 3 nozzles per row	2-row, tractor-mounted Niagara, 3 nozzles per row
Rate of dust per acre	35 lbs.	20 lbs. first 3 applications, 30 lbs. last 3 applications	20 lbs. first 3 applications, 40 lbs. last 3 applications
Sprayer	2-row, tractor-drawn Bean, 3 nozzles per row	2-row, tractor-drawn Bean, 3 nozzles per row	2-row, tractor-drawn Bean, 3 nozzles per row first 3 applications, 5 nozzles per row last 3 applications
Rate of spray per acre	125 gal.	100 gal. first 3 applications, 150 gal. last 3 applications	100 gal. first 3 applications, 150 gal. last 3 applications
Pressure	400 lbs.	350 lbs.	350 lbs.
Application dates, dusts and sprays	July 12 & 23, Aug. 3, 12 & 22, Sept. 3	July 15 & 31, Aug. 9, 19 & 27, Sept. 3	July 12 & 24, Aug. 2, 12 & 24, Sept. 3
First killing frost	Sept. 29	Sept. 21	Sept. 29
Harvesting dates	Oct. 2 & 3	Oct. 4-8	Oct. 12 & 13

of the zinc-containing fungicides. The influence of zinc when applied to the leaves was further demonstrated by comparing the 1948 yields from plots 25 and 27. Plot 25 received a copper-zinc mixture containing Tri-Basic Copper Sulphate and zinc sulphate furnishing 2.58 pounds of metallic copper and 0.60 pounds of metallic zinc per 100 gallons of water. Plot 27 received only Tri-Basic Copper Sulphate at the rate of 2.12 pounds of metallic copper in the same quantity of water. A highly significant yield of 30.9 bushels existed between the 2 plots in favor of the one receiving zinc sulphate.

TABLE 2.—*Adjusted mean yields in bushels per acre for the years 1946, 1947 and 1948.*

Plots	Materials	1946	1947	1948
	DUST TREATMENTS			
1[1]	5 per cent DDT	160.9 160.6	267.4	275.7
2	7 per cent HE-178 (Zinc Ethylene Bisdithiocarbamate) and 5 per cent DDT	158.6		
3	10 per cent Zerlate and 5 per cent DDT	161.6	305.0	295.7
4	6 per cent Dithane Z-78 and 5 per cent DDT		270.0	
5	8 per cent Dithane Z-78 and 5 per cent DDT			295.1
6	8 per cent Parzate and 5 per cent DDT			314.6
7	6 per cent Copper-A Compound and 5 per cent DDT	156.1	262.9	
8	7 per cent Tri-Basic Copper Sulphate and 5 per cent DDT	157.6	259.7	286.8
9	5.5 per cent Cuprocide and 5 per cent DDT			289.9
	DUST AND SPRAY TREATMENTS			
10.	5 per cent DDT first 3 applications, Zerlate and DDT 2-1-100[2] last 3 applications		259.4	
11	5 per cent DDT first 4 applications, Dithane D-14, Zinc Sulphate and DDT 2 qts. 1-1-100 last 2 applications			288.9
	SPRAY TREAMENTS			
12	Phygon and DDT 1-1-100	156.8	272.2	
13	Polyethylene Polysulfide and DDT 2 qts. 1-100	161.0		
14	Polyethylene Polysulfide, Phygon and DDT 1 qt. 1-1-100	161.2		
15	Zerlate and DDT 2-1-100		284.1	
16	Dithane D-14, Zinc Sulphate, Lime and DDT 2 qts. 1-½-1-100	173.8	288.9	
17	Dithane D-14, Zinc Sulphate and DDT. 2 qts. 1-1-100			314.3
18	Zinc Sulphate, Lime and DDT 1-½-1-100		270.4	
19	Zinc Sulphate last 3 applications and DDT 1-1-100			300.1
20	Zinc Sulphate first 3 applications and DDT 1-1-100			305.9
21	Zinc Sulphate 6 applications and DDT 1-1-100			304.8
22	Parzate[3] and DDT 2-1-100	168.9	279.0	314.6
23	Dithane Z-78[4] and DDT 2-1-100	168.9	275.3	
24	Zinc Nitrodithioacetate, Filmfast and DDT 4-½-1-100			307.9
25	Tri-Basic-Nu-Z and DDT 6-1-100			312.2
26	Copper-Zinc Chromate and DDT 2-1-100			303.9
27	Tri-Basic Copper Sulphate and DDT 4-1-100	154.0	269.0	281.3
28	Copper Oxychloride Sulphate and DDT 4-1-100		273.0	
29	Bordeaux Mixture and DDT 8-8-1-100	167.6	269.0	
30	Manganese Ethylene Bisdithiocarbamate and DDT 2-1-100	161.9		
	NO TREATMENT			
31		141.5	257.3	
	Least significant difference:			
	5 per cent level	26.2	24.5	17.5
	1 per cent level	34.9	32.6	23.3

[1]Two 5 per cent DDT treatments in 1946.
[2]All spray materials are expressed in standard units of weight or liquid measure sufficient to make 100 gallons of spray mixture. For example, Zerlate and DDT 2-1-100 means 2 pounds of Zerlate and 1 pound of DDT with sufficient water to make 100 gallons of spray mixture.
[3]Designated as Zinc Ethylene Bisdithiocarbamate in 1946.
[4]Designated as HE-178 (Zinc Ethylene Bisdithiocarbamate) in 1946.

Three copper dusts and 3 copper sprays were used at some time during the 3-year period. There was no instance where the yield from any one was significantly higher than a no-treatment plot or one receiving 5 per cent DDT. In 1946, 3 of the 4 copper-treated plots yielded less than plot 1 receiving 5 per cent DDT. Only when zinc was included in the copper-containing materials, such as Tri-Basic-Nu-Z and Copper-Zinc Chromate, were the yields among the highest.

The vines on plots treated with the zinc-containing dusts and sprays were greener at the time of the first killing frost than vines on other plots. An examination of the plants indicated the presence of considerable new foliage. Although the foliage was not weighed or the degree of color recorded, there was a positive correlation between the yields and the amount of green foliage exhibited in kodachromes taken one week previous to frost.

Summary

1. Several copper- and zinc-containing dusts and sprays were applied to potatoes during 1946, 1947 and 1948 at 3 different locations, each having a different soil type, in the Red River Valley of North Dakota.
2. No fertilizer was applied the first 2 years. In 1948 a 4-12-8 fertilizer was used at the rate of 440 pounds per acre.
3. A triple lattice design was used each year for arranging the 16 treatments, each replicated 6 times. The relative efficiency of this design, when compared with the randomized block, was 201, 155 and 138 per cent, respectively, during each of the 3 successive years.
4. Early blight, *Alternaria solani,* was absent in 1946, and varied from slight to moderate in 1947, and appeared as a very slight infection in 1948. Late blight, *Phytophthora infestans,* only appeared as a trace in 1948.
5. The injury caused by the common potato insects was reduced by using DDT.
6. The results obtained during the dry season of 1946 indicated the zinc-containing sprays may have been a factor in producing larger yields.
7. In 1947 the plot receiving Zerlate dust had a highly significant yield when compared with the no-treatment plot or the one receiving 5 per cent DDT. The yields from plots sprayed with Zerlate and Dithane D-14 were significant when compared with the no-treatment plot.
8. In 1948 plots dusted with Zerlate and Dithane Z-78 produced significant yields when compared with the 5 per cent DDT plot. The yield from the Parzate-dusted plot was highly significant.
9. The 5 plots sprayed with zinc-containing fungicides in 1948 showed highly significant yields when compared with the plot receiving 5 per cent DDT.
10. The use of zinc sulphate alone on plots 19, 20 and 21 resulted in highly significant yields when compared with plot 1.
11. Plot 25, Tri-Basic-Nu-Z, received 2.58 pounds of metallic copper and 0.60 pounds of metallic zinc in each 100 gallons of spray. Plot 27, Tri-Basic Copper Sulphate, received 2.12 pounds of metallic copper in the same quantity of spray. A highly significant difference of 30.9 bushels existed between the yields of these 2 plots in favor of the one sprayed with the zinc-containing fungicide.
12. There was no instance where the yield from a plot dusted or sprayed with a copper fungicide was significantly higher than a no-treatment plot or one receiving 5 per cent DDT.

13. When used at the rate of 1 pound per 100 gallons of water, there was no external evidence that zinc sulphate injured the foliage.
14. The results of this investigation have shown that the yields of potatoes grown in the Red River Valley of North Dakota were increased by applying zinc-containing dusts and sprays to vines that showed no external symptoms of zinc deficiency.

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THE WASECA, CHISAGO AND SATAPA POTATOES [1,2]

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The Minnesota Agricultural Experiment Station has been engaged in potato breeding work with the objective of developing for the potato growing areas of Minnesota varieties producing high yields and tubers of satisfactory market and table quality. While breeding work is also in progress on disease resistance, particularly common scab, late blight and latent mosaic, the three varieties herein described are not superior to the common varieties in this respect. They represent improvements in market and culinary quality and in adaption to the principal potato growing regions of Minnesota.

DEVELOPMENT AND ORIGIN

The three varieties were produced by outcrossing inbred lines on to the commonly grown varieties as indicated in the pedigrees, Chart 1. The inbreds were developed by cycles of selfing and crossing. The breeding plan was to develop lines breeding relatively true for the desired characters and then to cross them on adapted varieties to combine with these characters high yield and wider adaptability.

The Waseca variety was obtained by crossing the Triumph variety with an inbred selection 15-2-10. The cross was made in 1939 and the initial selections in the cross in 1940. The selection 15-2-10 bred relatively true for earliness, large attractive tubers of uniform size, with smooth shallow eyes and a thick skin or periderm. Its yield was low in comparison to commercial varieties.

Satapa was obtained from a cross of Red Warba with selection 20-4 made in 1939. The initial selections in the hybrid progeny were made in 1940. Selection 20-4 was obtained by a cycle of selfing and

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[2]These varieties are the result of potato breeding work carried on by the Minnesota Agricultural Experiment Station at University Farm, and the branch stations at Grand Rapids, Cookston and Duluth in cooperation with the State Department of Agriculture, Dairy and Food, and the Division of Fruit and Vegetable Crops and Diseases, United States Department of Agriculture.

crossing of related lines. It was medium early, and bred relatively true for uniform size per hill of exceptionally smooth, round, thick tubers.

The Chisago was produced by combining some of the best characters of the three varieties, Katahdin, Russet Burbank and Cobbler. Selection 66-1 having fertile pollen, a low set of desirable tubers was selected from a selfed progeny of the Katahdin and crossed with the Russet Burbank. From this cross an early selection was obtained, with the smoothness and inconspicuous eyes of the Russet Burbank with a lower tuber set. The yield of this selection 13-1 was slightly lower than the commercial varieties. Selection 13-1 was then crossed in 1938 with the Irish Cobbler producing a progeny from which the Chisago variety was selected.

Identifying Characteristics

Waseca

Description. Plants small to medium in size, compact to spreading; stems medium in thickness, angles inconspicuous, nodes slightly swollen, green, internodes slightly pigmented, wings inconspicuous, straight, single; stipules medium in size, spreading, green; leaves long, narrow, slightly rugose, dark green, medium to closed type; midrib green, pubescent; petioles green and pubescent; primary leaflets medium in size, ovate lobed, five pairs; petiolules green but pigmented at the base; secondary leaflets many on midrib between pairs of primary leaflets, on primary petioles, at junction of mid-rib and petioles of primary leaflets; tertiary leaflets many; inflorescence axillary, little branched, leafy bracts scarce; penduncles short, green, pigmented, pubescent; pedicels short, pigmented.

Flowers few, abscising; calyx lobe tips short to medium in length, awl shaped, green with slight pigment, pubescent; corolla small (diameter 21-23 mm.), color white with slight tinge of purple; anthers small, yellow orange; pollen scant to none, sterile; style straight, short to medium in length; stigma globose, green.

Tubers medium to large, oblong to round, medium in thickness; skin smooth, self-colored, red; eyes (medium shallow in depth) red; flesh white; sprouts red at base; maturity very early.

Chisago

Description. Plants medium to large in size, erect to spreading; stems medium to thick, angled; nodes slightly swollen, green; internodes slightly pigmented; wings prominent, wavy, double; stipules large in size, spreading, green; leaves medium in size, green, medium type; mid-

rib green, slightly pubescent; petiole green, slightly pubescent; primary leaflets large in size, ovate lobed, four pairs; petiolules green but pigmented at the base; secondary leaflets numerous, on midrib between pairs of primary leaflets, on primary leaflet petioles, at junction of midrib and petioles of primary leaflets; tertiary leaflets scarce; inflorescence on petiole, branched, leafy bracts often present sometimes forming double wings on peduncle; peduncles long, green, pigmented; pubescent; pedicel medium in length pigmented, pubescent.

Flowers many, lasting; calyx lobe tips short to long, awl shaped, green with slight pigment, pubescent; corolla medium to large (diameter 35-37 mm.) color white; anthers medium in size, orange; pollen scant, sterile; style curved, medium long; stigma globose, green.

Tubers large, oblong to round with blunt ends medium in thickness; skin smooth, white; eyes small, shallow; white; flesh white; sprouts pink at tips; maturity early.

Satapa

Description. Plants medium in size, spreading; stems thick, prominent angles; nodes only slightly swollen, green; internodes slightly pigmented, wings prominent, slightly wavy, double; stipules medium in size, spreading, green; leaves long, medium wide, rugose, dark green, closed type; midrib green, slightly pubescent; primary leaflets medium in size, ovate lobed, five pairs; petiolules green but pigmented at the base; secondary leaflets many, on midrib between pairs of primary leaflets, on primary leaflet petioles, at junction of midrib and petiole of primary leaflets; tertiary leaflets many; inflorescence axillary, little branched, leafy bracts scarce; peduncles medium in length, green, pigmented, pubescent; pedicels medium in length, pigmented, pubescent.

Flowers few, not too lasting; calyx lobe tips short to medium in length, linear, green with slight pigment, pubescent; corolla medium in size (diameter 30-32 mm.), color deep red, purple; anthers medium in size, orange; pollen scant, sterile; style straight, medium long; stigma globose, green.

Tubers medium to large, round, slightly flattened, thick short, skin smooth, self colored, pale red; eyes very shallow, red; flesh white; sprouts red at base; maturity midseason.

Adaptation and Quality

These three varieties appear to be well adapted to the potato growing areas in Minnesota. They have been tested in four distinct areas; the Red River Valley, peatland, late region, and early market region

In these tests they have yielded as well or better than the old standard commercial varieties as indicated in table 1.

TABLE 1.—*Comparative yield of potato varieties in four potato regions in Minnesota for a six-year period from 1942-1947.*

Variety	Red River Valley	Peatland	Late	Early Market	Mean
	Bus.	Bus.	Bus.	Bus.	Bus.
Extra Early					
Red Warba	201.2	198.5	171.0	242.0	203.2
Waseca	191.8	181.0	176.8	214.0	190.9
Early					
Cobbler	213.5	186.2	174.7	243.0	204.4
Triumph	174.5	165.2	167.2	173.0	170.0
Chisago	193.3	170.0	180.7	242.0	196.5
Midseason					
Chippewa	197.2	181.2	225.3	222.0	206.4
Pontiac	207.8	185.8	213.5	230.0	209.3
Satapa	208.0	198.0	228.5	238.0	218.2

The dry matter content of these three varieties is not so high as Cobbler or Red Warba; however, the cooking quality is usually considered very good. Although they are not so mealy in texture, they hold together well when boiled. The per cent dry matter is indicated in table 2.

TABLE 2.—*Dry matter and per cent of total yield of tubers over 1⅞" in diameter for potato varieties in Minnesota.*

	Dry Matter per Cent	Yield of Tubers over 1⅞" Diameter per Cent
Red Warba	19.2	89
Waseca	17.0	88
Cobbler	19.7	86
Triumph	18.0	88
Chisago	18.6	92
Chippewa	17.9	88
Pontiac	17.1	91
Satapa	18.0	89

A major improvement in Waseca and Chisago over the old standard varieties is in the production of more medium and large tubers as shown in table 3. In Waseca 86 per cent of the yield of U. S. #1 size tubers is over 2¼ inches compared with 83 per cent for the Red Warba. In Chisago 90 per cent is of the yield of this size compared with 84 per per cent in Cobbler and 81 per cent in Triumph. In Satapa the per cent-

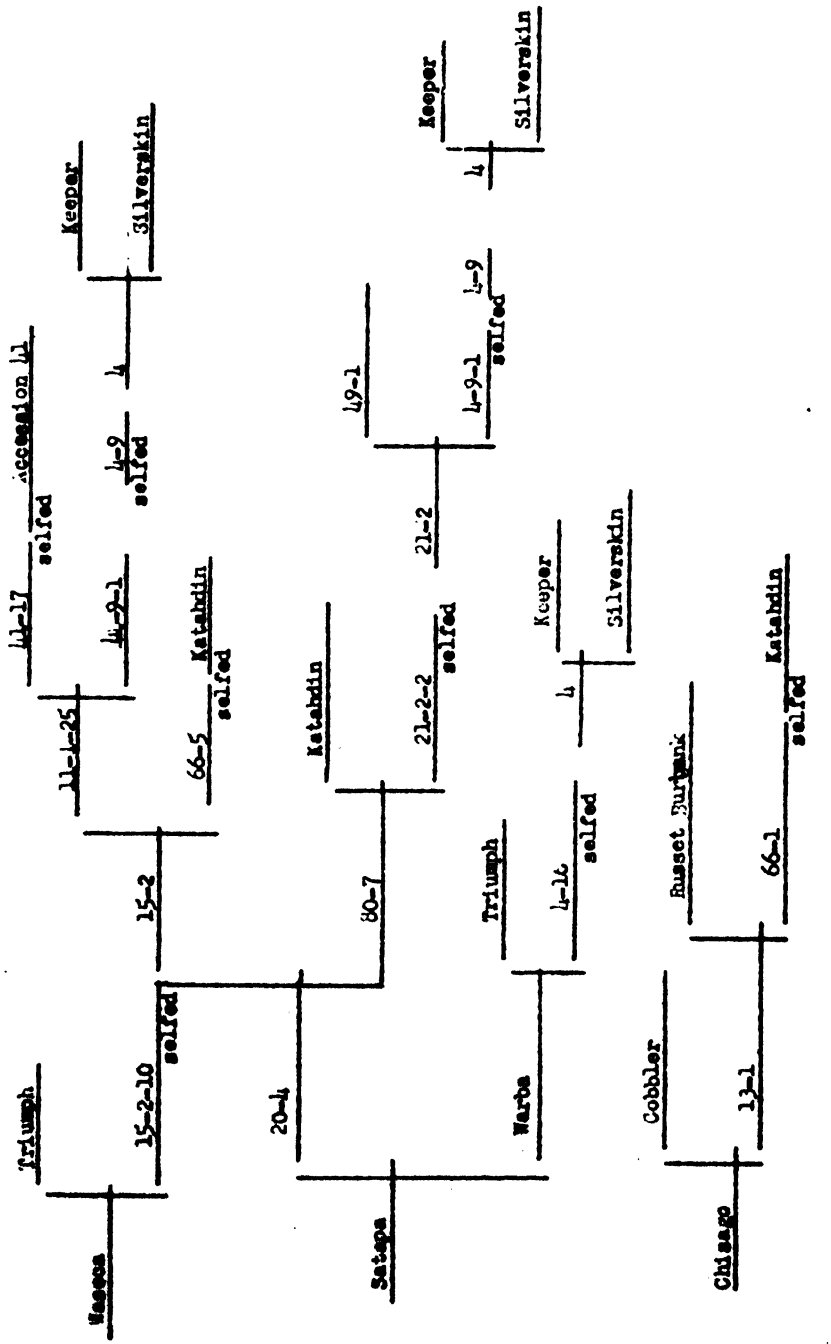
age is slightly less than in Pontiac. The greater uniformity of size which is characteristic of these new varieties is only slightly indicated in table 3. In smoothness of surface, shallowness of eyes and general desirability from a market standpoint the Waseca, Chisago, and Satapa are superior to the other varieties in their respective maturity classes. The uniformly round smooth tubers of the Satapa with very shallow eyes makes this variety particularly adapted for restaurant and hotel use where automatic peelers are used.

TABLE 3.—*Per cent of yield of U. S. No. 5 size, falling into indicated size classes.*

Variety	1⅞" - 2¼" per Cent	2¼" - 3" per Cent	Over 3" per Cent
Red Warba	16.66	69.65	13.68
Waseca	11.32	64.45	22.25
Cobbler	15.51	72.15	12.33
Triumph	18.62	73.14	8.22
Chisago	9.98	66.40	23.61
Chippewa	21.00	66.10	12.90
Pontiac	14.35	64.95	20.70
Satapa	16.47	70.40	13.12

DISSEMINATION

Sufficient seed stock of the three new potato varieties Waseca, Chisago, and Satapa will be in the hands of foundation and certified seed growers in 1949. Any one interested in procuring seed stocks of this variety should communicate with A. G. Tolaas, Potato Seed Certification, St. Paul, Minnesota.


Waseca
Triumph
15-2-10
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11-17
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Accession 11
4-9-1
4-9
selfed
4
Keeper
Silverskin
66-5
selfed
Katahdin
Satapa
20-4
80-7
Katahdin
21-2-2
selfed
21-2
49-1
4-9-1
selfed
4-9
4
Keeper
Silverskin
Warba
Triumph
4-16
selfed
4
Keeper
Silverskin
Chisago
Cobbler
13-1
Russet Burbank
66-1
selfed
Katahdin

SECTIONAL NOTES

INDIANA

I have just returned from a trip in the New England States starting in Pennsylvania, going through New York, into Maine and Canada and, as you say, unless rain comes before long the crop will be rather short. We in Indiana have had a very agreeable season with timely rains and, with the exception of the past four or five days, the temperature has been very agreeable. It is somewhat warm at the present time, similar to the eastern conditions.

The early crop of potatoes is doing very well and the main or late crop looks very promising. Quite a few of the early potatoes have been harvested. The Triumph has been yielding well in our early-producing areas.

We have no report of any one starting anything in regard to price controls or allotted acreage, and if things keep on going as they are, our commercial acreage will be limited to very few growers in the extreme southern part of the state and also in the muck areas in the northern part. Our acreage is badly depleted for this year. W. B. WARD.

MISSOURI

Harvesting of the Jackson-Clay-Ray potato crop started the latter part of June. Yields in most cases were not as high as had been expected, with soft rot showing up in a large number of fields. The size was also below average.

Although late blight made its appearance in a number of fields it was apparently not so damaging to potato fields as was the wet weather. All specimens sent to the plant pathology department of Missouri University were not infected with late blight, and it is thought that the diseased condition was caused by excessive soil moisture.

Marketing of this year's crop has been a problem because of the percentage of rots going into the bag. Although many of the growers are grading and washing their potatoes carefully, there is still decay showing up when the potatoes reach their destination. The government buyers have purchased several cars that meet their specifications and it is probable that this year there will be many more cars sold to the government than we have sold in the past. BEN F. VANCE.

NEW JERSEY

New Jersey's worst drought for decades was finally broken on the 12th of July after a period of 42 days. The Cobbler variety has been

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seriously injured, and, as a result, many growers will harvest less than ¼ of their normal yield. Katahdins and other late-maturing varieties have been saved, although the yields will range from 25 to 50 per cent below normal.

The dry weather, being accompanied by high temperatures, caused most of the potatoes to stop growth. Consequently, the tubers went into a temporary dormant period which was quickly broken and, as a result many of these tubers have sprouted under the ground. These sprouts are to be found on all varieties and the condition is prevalent throughout the state. The sprouts range in size from buds to six inches or more in length and some are producing new plants. A condition of this type is a serious threat to the industry. The Cobbler variety is now being harvested and our growers will start harvesting the Katahdins about the 1st of August.

Many new irrigation systems have been installed and all irrigated fields, in general, will produce nearly normal yields. JOHN C. CAMPBELL.

NEW YORK

June has been much hotter than normal, and very dry. Early potatoes have suffered and the young tubers and stolons are sending out sprouts which are forming leaves. The few showers have helped, but little. Our late potatoes, however, still look good.

Our acreage is generally conceded to be within allotment. We have a fairly good "sign-up." Many growers outside the program have reduced their acreage. The prospects not too good for a normal crop.

Our State Committee expects to hold a series of meetings during July and August; a tentative draft has already been written. Because of the nearness of markets and the system of distribution our marketing agreement requirements will differ from our usual agreement, if adopted.

There is a slight increase in the acreage entered. Essex shows the biggest increase. This variety is very popular because of its vigorous growth, blight resistance, and high yielding capacity. Other blight immune varieties are being tested.

FIELD DAYS

The Empire State Potato Club Field Day, August 4, Amidon Farms, LaFayette.

Adirondack Potato Growers, August 11, Tom Norman Farm, Saranac Lake.

Steuben County Potato Growers Field Day, August—date not yet announced. H. J. EVANS.

New York

Although most of the New York acreage was planted early and under very favorable soil conditions, the crop has suffered badly since late May for lack of rain. The prospect on Long Island is especially serious except where irrigation is available. In this area the crop was off to a good start, but since mid-May we have had no rain. This means that drought hit the Long Island crop at a very critical period. Non-irrigated fields will likely show a heavy set which in turn means under-sized tubers and a low yield next fall. The conditions are almost as dry upstate, but the crop is not yet far enough along to be permanently injured by the drought. Much of the muck crop was permanently damaged by the freeze of the 8th of June.

The annual summer potato field day of the Empire State Potato Club will be held on the 4th of August on the farm of Maurice and Richard Amidon at LaFayette, New York. This site is on U. S. Route 11, about 1 mile south of the village. The Adirondack Tri-county Northern New York potato field day will be held at the farm of Thomas Norman of Saranac Lake, New York, on the 18th of August. The Steuben County Summer Potato Day is scheduled for the 20th—place to be announced.

The potato variety yield trials, including about 28 varieties, have been planted in replicated, randomized plots in Allegheny, Erie, Essex, Genesee, Nassau, Onondaga, Steuben, Suffolk and Tompkins counties. This provides a good comparison of the newer varieties because samples of the same stocks are used throughout the state. Trials with sprout inhibitors, weedicides, and chemical vine killers have been placed in several counties as a part of the research program of the Department of Vegetable Crops. Dr. W. A. Rawlins is testing soil fumigants and the residual effects of DDT, and Dr. F. M. Blodgett has instituted field experiments with the newer fungicide sprays. E. V. Hardenburg.

North Carolina

As in other sections of the Southeastern potato area, North Carolina began harvesting its crop of Irish potatoes earlier than usual this year. Early planting and a favorable growing season resulted in a proportionately earlier harvest. Practically all of the crop would have been marketed by the 25th of June if rains, during the latter part of the harvest season, had not retarded our digging operations. As a result of the recent heavy rains, a small acreage of Sebago, and in some

areas the Cobbler variety, still remain to be harvested as of the 4th of July.

By far the majority of the crop from North Carolina moved by trucks. Both shippers and dealers have expressed greater satisfaction concerning the rapid movement by trucks. Because of the short time the potatoes are in transit, there is much less risk of spoilage. The convenience of delivery is also a point expressed in favor of trucks. Furthermore, since many of the larger trucks are equipped with refrigeration, the potatoes will arrive on the terminal markets in much better condition than when in transit for several days.

A greater amount of interest has been stimulated among the growers in washing. The cost of the machinery is still the prohibitive factor involved for most growers. Also, many of the growers in eastern North Carolina are greatly impressed by the need of a variety of Irish potato to replace the Cobbler. By next season there will possibly be a decided shift from the Cobbler to Sebago. A great deal of interest is also being shown in some of the newer blight-resistant varieties. DANIEL T. POPE.

SOUTH CAROLINA

We are constantly hearing more and more good reports about the excellent yields of quality Sebagoes and the good prices received for this variety. Most of the potato land is now in cover crops. Growers are settling up accounts past due, from the disastrous crop of 1948 and are looking forward to more washing machines and double shift operation of all washers for next year. In general, they are feeling encouraged over the future of potato productions in this area. W. G. BARNES.

PROVINCE OF CANADA

The sales of the 1948 crop of certified seed potatoes are now completed although the season lasted longer than usual. Despite the large crop produced in 1948, practically every bushel was sold.

Although completed figures for the 1949 crop entered for certification are not yet available, it would appear that the acreage will be possibly slightly less in 1949 than that inspected in 1948. In Prince Edward Island the acreage of Katahdins and Sebagoes has increased at the expense of Irish Cobblers and Green Mountains. It is interesting to note that in Saskatchewan, where potatoes are not grown very extensively, in the acreage entered for inspection approximately 70 per cent is of the Netted Gem variety. This is probably caused by the fact


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that several areas have recently been brought under an irrigation scheme.

Even though some areas have suffered from drought, in most cases the crop is reported to be in reasonably good condition and unless it continues to be very dry the crop should be quite good. Flea beetles have been reported to be quite numerous in many sections, but have not done any serious damage to date. J. W. SCANNELL.

PROVINCE OF QUEBEC

Conditions are good everywhere. Most of our insects are well under control and our prospects, generally speaking, are very good.

Our acreage is about 8 per cent less than last year.

Although the soil moisture in the Eastern townships is low, it is good elsewhere. ROGER GAGNON.

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SPROUT INHIBITION OF NON-DORMANT CHIPPEWA POTATOES

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Purdue University, Lafayette, Ind.

(ACCEPTED FOR PUBLICATION JUNE 14, 1949)

Applying sprout-inhibiting treatment to potatoes as they are removed from storage would reduce the expense of the treatment by eliminating treatment of those tubers disposed of before natural dormancy is broken. Since potatoes are often already beginning to sprout when they are removed from the storage in the spring, it is essential to know what materials and what concentrations are most effective in inhibiting the sprouting.

Since inhibition of sprouting of potato tubers by a gas, probably ethylene, given off by apples in storage was first reported by Elmer (4), much effort has been directed toward finding a practical method of preventing sprouting.

Guthrie (5) reported that cut pieces of non-dormant potato tubers were prevented from sprouting by soaking the bases of the pieces in solutions of neutralized indoleacetic acid. The following year Guthrie (6) obtained good sprout inhibition with the methyl ester of alpha-

naphthaleneacetic acid, the ester being sufficiently volatile at room temperature that it could be introduced into uncut tubers in the vapor form.

Denny (1) treated tubers shortly after harvest with methyl ester of alpha-naphthaleneacetic acid. Sprouting was completely inhibited for seven months. Untreated tubers sprouted freely. When methyl ester of alpha-napthaleneacetic acid was used in talc and dusted onto the tubers, 25 milligrams per kilogram were sufficient to inhibit sprouting.

Denny, *et al.* (2) found 1 to 1.3 kilograms of potato tubers were inhibited from sprouting completely for one year when exposed to filter paper impregnated with 400 milligrams of methyl ester of napthaleneacetic acd. When only 100 milligrams of this chemical were used on the same amount of tubers small sprouts appeared in six to eight months. Ten and thirty milligrams gave only negligible results. Delaying the application until six weeks after harvest resulted in a smaller amount of sprout growth at 15° C. than when the growth regulator was applied at once.

The results of Thomas and Riker (10) indicated that the methyl ester of alpha-napthaleneacetic acid was superior to any of the other substances used, and 0.2 per cent concentration gave almost as good results as 0.6 per cent. The only other material which inhibited sprouting to any marked degree was alpha-napthaleneacetic acid, but was markedly inferior to the methyl ester. Their results indicated that methyl ester of alpha-napthaleneacetic acid was equally effective when applied as a dust, or spray, but gave somewhat unsatisfactory results when applied as a vapor. Cobbler, Russel Rural, and Triumph treated with 0.4 per cent methyl ester of napthaleneacetic acid dust and stored for 40 days at above 70°F. were completely inhibited from sprouting. Sprouting on the Chippewa variety was not completely inhibited. Time of treatment studies indicated that with the variety Chippewa, fall treatment was less effective than treating just before warm weather was expected. They also recommended that applications of the chemical be made before the tubers break dormancy and begin to sprout.

Smith (8) reported 0.9 to 1.0 gram of methyl ester of alpha-napthaleneacetic acid per bushel of potatoes to inhibit sprouting when tubers were stored 4 to 5 months at 50° to 55°F.

Thayer (9) also found that methyl ester of naphthaleneacetic acid dust inhibited sprouting of potato tubers. The chemical was applied at the rate of 1 and 3 pounds of 2.2 per cent of methyl ester of naphthaleneacetic acid to eleven bushels of potatoes.

Pujals *et al.* (7) also were able to retard sprouting of tubers by application of methyl ester of alpha-naphthaleneacetic acid.

Materials and Methods

Indiana U. S. No. 1 washed Chippewa potatoes were weighed into twelve and one-half pound samples and allowed to stand at 50° to 60° F. from the 27th of February to the 12th of March, at which time treatments were applied. Sprouts were then one-half to one inch long. All sprouts were intentionally broken off in the process of applying the treatments. The sprouts on the potatoes which were untreated were also removed.

The growth-regulating materials used in this experiment were sodium salt of betanaphthoxyacetic acid, sodium salt of naphthaleneacetic acid, naphthaleneacetic acid, methyl ester of beta-naphthoxyacetic acid, and methyl ester of alpha-naphthaleneacetic acid. The experiment was so designed that the effects of three concentrations,—1, 3, and 9 grams per bushel as well as three methods of application,—(1) dusted, (2) dipped and dried at 70° F., and (3) dipped and dried at 135° F. were observed. All treatments were replicated four times.

Pyrax ABB talc was used as the carrier in the dust treatments. It was found that 15 grams of talc were necessary to cover 12.5 pounds of potatoes completely, an amount of dust approximately ten times that used for treating potatoes under commercial conditions. Each sprout inhibiting material was dissolved in five cubic centimeters of 95 per cent ethyl alcohol and dripped into the talc while being agitated in a Waring Blender. After mixing, the alcohol was allowed to evaporate and the dust reagitated to break up any lumps formed by the mixing process. The dust treatments were applied by putting the dust and tubers in a closed container and rolling gently.

The aqueous solutions for the dips were prepared by adding the chemical to 220 cubic centimeters of water. It was found that 12.5 pounds of potatoes removed approximately 220 cubic centimeters from the dip solution due to absorption and surface adhesion. In the case of naphthaleneacetic acid, it was necessary to dissolve the material in alcohol first and add the alcohol solution to the water. The tubers remained in the dip solution approximately three minutes. Upon removal from the dip they were placed in standard greenhouse flats lined with heavy paper. No additional treatment was given those dried at 70° F. Those dried at 135° F. were placed in a chamber and subjected to a thermostatically controlled air blast for twenty minutes. This temperature was based on that used in commercial dryers on potato washing equipment.

In applying the treatments caution was exercised to avoid contamination of the non-volatile materials by the volatile methyl ester materials. The treatment rooms had sufficient ventilation to evacuate rapidly any volatilization occurring from the esters. Other materials were either removed from the room or kept in air tight containers while a volatile material was being handled.

After treatment the tubers were removed to a large attic having adequate natural and forced ventilation. The two volatile ester materials were separated individually, and also from the non-volatile materials by thirty to thirty-five feet. Untreated samples and samples receiving talc only were randomized in each area with the treated ones. The treatments were randomized and stacked. A two-inch spacer was placed between each flat to allow air circulation over the tubers.

A recording thermograph was placed among the flats in each area. During the course of the experiment the most extreme variation in temperatures between the three areas was 0.9° C. No special effort, other than to avoid extreme temperatures by opening and closing windows occasionally, was made to maintain a specific room temperature. The average room temperature during the course of the experiment was 58° F.

On the 22d of April, after 40 days storage, the experiment was terminated. Sprouts were immediately removed from the tubers and the sprout weights and the tuber weights from the treatments recorded. Because of a high incidence of "rosette" type of sprouting, it was deemed impractical to make any attempt to measure sprout length.

Results

The results of this experiment are presented in table 1. None of the treatments resulted in complete inhibition of sprouting. Treatments were considered to have given satisfactory control only if their average sprout weight in grams did not exceed the average sprout weight of the best treatment by more than the amount required for significant differences at the 5 per cent level.

Effect of Different Hormones

Naphthaleneacetic acid and its sodium salt were the only materials used which gave satisfactory inhibition of sprout growth of non-dormant Chippewa potatoes. The methyl ester of alpha-naphthaleneacetic acid, although inhibiting sprout growth markedly, gave poor results when compared with the best treatment. The sodium salt and methyl ester of beta-naphthoxyacetic acid had no appreciable effect on sprout formation in this experiment.

TABLE 1.—*Average sprout weight and average tuber weight lost.*

Chemical	Method of Application	Ave. Sprout Wt., Grams			Ave. Tuber Wt. Lost, Lbs.		
		1 Gm. Bu.	3 Gm. Bu.	9 Gm. Bu.	1 Gm. Bu.	3 Gm. Bu.	9 Gm. Bu.
Sodium Salt of Beta-naphthoxyacetic Acid	Dip-dried 70°F.	203.7	198.5	206.3	2.6	2.8	2.7
	Dip-dried 135°F.	187.0	199.8	201.4	2.9	2.7	2.7
	Dusted	202.6	194.6	198.6	2.7	2.7	2.7
Sodium Salt of Naphthaleneacetic Acid	Dip-dried 70°F.	125.0	39.6	22.6	2.6	2.3	2.2
	Dip-dried 135°F.	109.3	77.2	48.9	2.2	2.4	2.3
	Dusted	96.2	29.8	18.3	2.6	2.3	2.3
Naphthaleneacetic Acid	Dip-dried 70°F.	99.2	52.4	14.5	2.5	2.4	2.5
	Dip-dried 135°F.	112.9	87.0	34.6	2.4	2.6	2.2
	Dusted	66.0	33.1	26.1	2.5	2.3	2.4
Methyl Ester of Beta-naphthoxy-acetic Acid	Dip-dried 70°F.	208.2	198.5	197.7	2.3	2.6	2.4
	Dip-dried 135°F.	201.8	201.1	207.0	3.1	2.6	2.6
	Dusted	204.5	192.6	187.8	2.9	3.2	3.3
Methyl Ester of Alpha-naphthalene-acetic Acid	Dip-dried 70°F.	164.3	134.2	115.4	2.6	2.9	2.7
	Dip-dried 135°F.	163.8	140.3	99.5	2.8	2.6	2.4
	Dusted	107.3	92.0	44.5	1.9	2.8	2.6
No Treatment (Check)			204.9			2.7	
Talc Only (Check)			205.3			2.8	
*L. S. D. 5 per cent			15.5			0.4	
L. S. D. 1 per cent			20.5			0.5	

*L. S. D. applies to differences between chemicals, methods of application, and concentrations.

EFFECT OF METHOD AND RATE OF APPLICATION

Although naphthaleneacetic acid, its sodium salt, and the methyl ester, applied at the rate of 1 and 3 grams per bushel of tubers, resulted in highly significant reduction in sprout weight as compared with tubers receiving no treatment, the sprouting was not sufficiently inhibited for satisfactory control. Likewise, 9 grams of these materials gave highly significant reduction in sprout weights, but only the 9 gram treatments with naphthaleneacetic acid and its sodium salt were judged to have given adequate control (Figures 1 and 2), and then only when applied in certain ways.

Of the five treatments considered to give relatively good control three were applied in talc and two as aqueous dips dried at 70° F. The sodium salt of naphthaleneacetic acid, applied at the rate of 9 grams per bushel, was equally effective in talc and aqueous solution when the tubers were dried at 70° F. Three grams of the sodium salt applied in dust

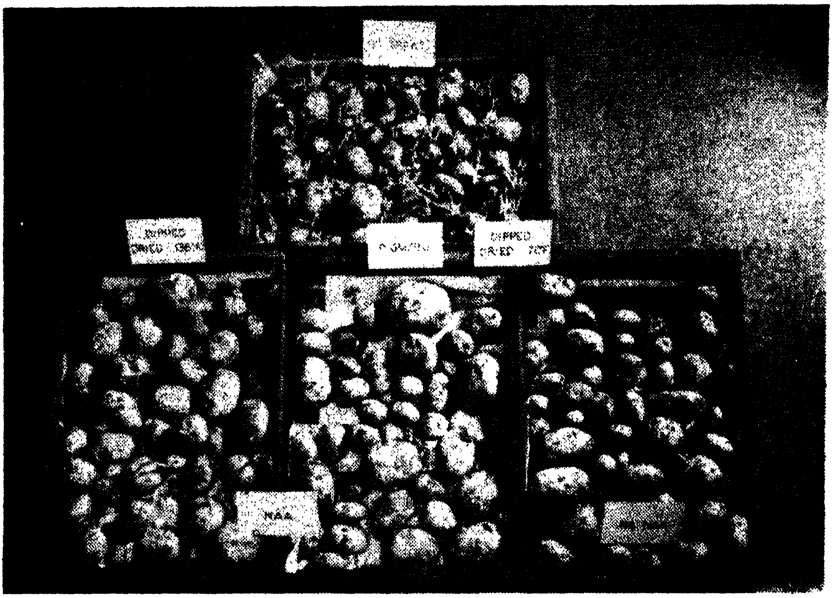

FIG. 1. The three dip treatments giving best control, all employed 9 grams of hormone per bushel of potatoes. The tubers in the two flats on the left were treated with naphthaleneacetic acid and those in the flat on the extreme right with the sodium salt of naphthaleneacetic acid. The tubers in the two flats on the right were dried at 70° F. and those in the one on the left at 135° F. Tubers in the flat at the top received no treatment.

control which was not significantly different from the best results obtained.

Naphthaleneacetic acid at the rate of 9 grams per bushel of tubers gave satisfactory control when applied as dust and as aqueous dip dried at 70° F.

All treatments applied as dips and dried at 135° F. resulted in significantly higher sprout weight than the treatment giving the best control.

There was a high correlation between average sprout weight and average tuber weight loss; the r^2 value being 0.83. Because of the extremely low humidity of the storage room all treatments lost considerable moisture and shriveled badly.

Discussion

Even though sprouting was markedly decreased by certain hormones, complete inhibition was not achieved. These results are in accordance with the statement of Thomas and Riker (10) that hormone application should be made before tubers break dormancy and begin to sprout.

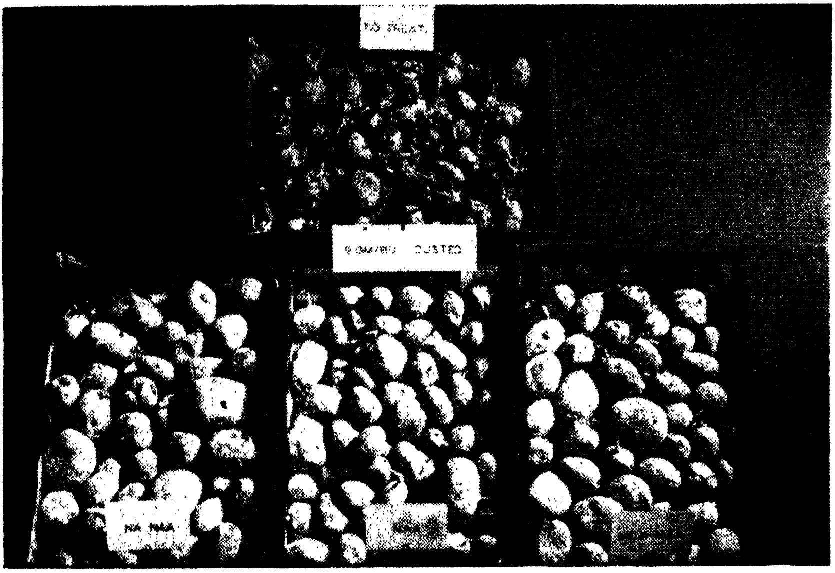

FIG. 2. The three best dust treatments were from left to right, Sodium Salt of Naphthaleneacetic acid, Napthaleneacetic acid and Methyl Ester of Alpha-Napthaleneacetic acid all applied at the rate of 9 grams in talc per bushel of potatoes. Tubers in the flat above received no treatment.

The good results obtained with naphthaleneacetic acid and its sodium salt as compared with the relatively poor results obtained with the methyl ester are surprising in view of the excellent results of other workers (1, 2, 6, 7, 8, 9, and 10) with the latter compound.

The effectiveness of the dip method is of importance inasmuch as it may be possible to treat potatoes by this method at the time they are washed, just prior to drying, thus combining operations to reduce handling costs. At all rates of application of naphthaleneacetic acid and its sodium salt the sprout growth was significantly less when the tubers were dried at 70° F. than when dried at 135° F. Since the latter temperature is often used to dry tubers after the washing process, a somewhat larger amount of material may be necessary to obtain good results under these conditions. With methyl ester of alpha-naphthaleneacetic acid there was no statistical difference in control between those dried at 70° F. and those dried at 135° F. when treated with 1 and 3 grams. However, when 9 grams of methyl ester were used, those tubers dried at 135° F. produced significantly less sprout growth than those dried at 70° F. indicating that perhaps the methyl ester of naphthaleneacetic acid would be more effective at higher temperature. Such results would be in accord with those of Pujals *et. al.* (7) who found methyl ester to be

more effective when the tubers were stored at 68° - 82° F. than at 50° - 55° F. This was believed to be due to the more rapid and complete vaporization of the material.

Summary and Conclusions

Indiana-grown washed Chippewa potato tubers which had broken dormancy were used in this experiment.

Methyl ester of alpha-naphthaleneacetic acid gave poor control of sprout growth, on potatoes which had already broken dormancy.

The sodium salt and methyl ester of beta-naphthoxyacetic acid gave no appreciable control of sprouting.

Naphthaleneacetic acid and its sodium salt at the rate of 9 grams per bushel gave satisfactory inhibition of sprouting when the treated tubers were stored for 40 days at an average temperature of 58° F. Treatments were equally effective where applied in talc, or in aqueous solution and dried at 70° F.

Drying dipped tubers at 135° F. significantly reduced the effect of naphthaleneacetic acid and its sodium salt at all concentrations used as compared with drying at 70° F. The same drying temperature, however, increased significantly the effect of methyl ester of naphthaleneacetic acid at the highest concentration used, as compared with drying at 70° F.

Treatment, after sprouts have elongated ½ to 1 inch, is probably not economically feasible since the dosage required is approximately 10 times that which is used to prevent sprouting of dormant potatoes.

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FIELD TESTS OF FUNGICIDE-INSECTICIDE COMBINATIONS IN MICHIGAN FOR 1948[1, 2]

J. H. MUNCIE AND W. F. MOROFSKY[3]

Michigan State College East Lansing, Mich.

(Accepted for publication, Feb. 11, 1949)

Further field trials were made at the Lake City, Michigan, Experiment Station employing 22 spray and 12 dust combinations of fungicides and insecticides in control of early blight and various potato insects. The plots consisted of four rows randomized and replicated three times for the sprays and duplicated for the dusts. For the spray plots two harvestings were made and for the dust plots three harvestings were made for each plot. The spray plots were 150 feet and dust plots 250 feet in length. Both series of plots were planted to the Katahdin variety on the 17th of May and harvested between the 13th and 15th of September. The plots were irrigated five times during the period from the 26th of July to the 24th of August. Spray and dust applications were made at approximately 10-day intervals as follows: July 9, 19, 29, August 9, 19, 31, and September 7. Sprays were applied with a tractor drawn engine-powered sprayer at 300 pounds pressure and the dusts with an engine-powered machine of 50 pounds capacity drawn by tractor. A canvas 25 feet in length and covering four rows, trailed behind the duster to confine the materials to the vines.

No late blight was found in these plots but it was present as a trace amount in the main potato field across the field road. Early blight was first seen in the plots on the 3rd of August, but gained little headway until

[1]Grateful acknowledgment is extended to all growers, commercial companies, county agents and experiment station workers who cooperated in this work. Especial gratitude is due Mr. A. M. Berridge, Supt., Lake City Experiment Station, for providing facilities for conducting this project, and to Mr. Dale Bray, graduate assistant in Entomology, for his assistance in making insect counts.

[2]Published by permission of the Director, Michigan Agricultural Experiment Station. Journal article number 1020 (n.s.).

[3]Research professor of Plant Pathology and Associate Professor of Entomology, respectively.

after the 24th when irrigation was discontinued and the vines were reaching maturity. Readings of early blight infection were made on the 17th and 24th of August and on the 13th of September just previous to harvesting.

Insect counts were made 2, 4, 6 and 8 days after each application of spray or dust from five complete sweeps including approximately 30 feet of row. Counts were made at ten-day intervals during the period from the 11th of July until the 9th of September inclusive.

Results of the spray materials tests are given in table 1 and show that the highest yield of U. S. number 1 potatoes was obtained from the plots sprayed with Zerlate + DDT (382.1 bu.) followed closely by zinc nitrodithioacetate (356.5 bu.), Dithane D-14 plus 50 W DDT, Parzate plus DDT and micronized cuprous oxide (Calumet and Hecla) plus DDT. The lowest yields were obtained with bordeaux mixture 8-4-100 plus DDT and Tribasic copper sulfate plus 1155, a mixture of 22.5 per cent DDT and 2.5 per cent chlordane used at the rate of 1 quart per 100 gallons. The results from the latter materials were not unexpected since there was some injury to the foliage after the first application of bordeaux mixture and later stunting of the vines and in 1947, chlordane used as a dust caused some wilting of the plants and a reduction in yield.

The table also shows that copper-zinc chromate gave best control of early blight followed closely by Zerlate, Dithane D-14, yellow cuprocide and cuprous oxide (Robertson Co.). Control of this disease seems to fall roughly into two classes, *viz*: Copper-zinc chromate and zinc-organic sulfur materials and (2) the inorganic copper materials with exceptions as mentioned above. The yield and control of early blight are not always closely related as shown by the plots sprayed with Parzate, Copper-zinc chromate and zinc nitrodithioacetate. In general, however, higher yields followed effective early blight control.

All of the insecticides tested gave practically 100 per cent control of flea beetles but there was considerable variation in effectiveness against common potato leafhopper, six-spotted leafhopper, spittle bug and aphids. The addition of chlordane to DDT was ineffective at the strength used in the control of spittle bug as was 25 per cent emulsion DDT and Parathion. This latter material, however, in combination with two fungicides gave perfect control of aphids, by far the best of all the materials used. Since none of these insects was present in great numbers at any time during the growing season, it is difficult to determine the true value of the insecticides employed, and only comparisons can be made.

Tests of dusts were also made with five different combinations of

TABLE 1.—*Insect and blight control on potato dust plots Lake City Experiment Station,* 1948.

Material and Dosage	Insect Control Percentage					Early Blight Per Cent Defolia-tion	Yield*
	Potato Leaf Hopper	Six-Spotted Leaf Hopper	Spittle Bug	Aphids	Potato Flea Beetle		U. S. No. 1 Bus. Per Acre
1. 629 + DDT (6 per cent Zn nitrodithioacetate + 5 per cent DDT)	76	48	44	93	100	48	242.3
2. TBC + Parathion (7 per cent Tribasic Cu + 1 per cent Parathion)	70	30	27	91	98	55	208.5
3. 629 + 308 + DDT (629 + Cu nitrodithioacetate (6 per cent) + 5 per cent DDT)	68	69	72	79	99	60	252.9
4. Parathion sp. + TBC (7 per cent cu + 1 per cent Parathion)	63	70	56	95	95	68	213.9
5. TBC + CM-155 (6 per cent cu, + 3 per cent DDT)	74	39	56	82	98	75	247.3
6. Zerlate + CME-1 (10 per cent Zerlate + 3 per cent DDT)	72	51	31	83	98	35	229.8
7. TBC + 602 (7 per cent cu + 3 per cent DDT)	66	64	50	90	100	63	190.2
8. TBC + 1156 (7 per cent cu + 3 per cent DDT + 1 per cent chlordane)	68	67	61	69	100	45	179.9
9. Z-78 + DDT (6 per cent Dithane Z-78 + 3 per cent DDT)	68	15	57	72	98	48	227.8
10. Y-cu + DDT (6.8 per cent yellow cuprocide + 3 per cent DDT)	74	51	50	72	100	55	193,1
11. DDT alone (3 per cent)	74	54	52	89	99	58	247.3

*Yield differences not significant at 5 per cent level.

insecticides and fungicides in 12 randomized duplicated plots. All dusts were ready mixed by the manufacturer to insure proper blending. Although space was lacking for more than duplicate plots, three harvestings of two 40-foot rows were made in each plot. Seven applications of dust were made on the same dates as the spray applications. Results of these tests are given in table 2. Because of soil variations there were no significant differences between yields. However, in early blight control Zerlate plus DDT was most effective followed by Tribasic copper sulfate plus 1155, Dithane Z-78 plus DDT, yellow cuprocide and Tribasic, both plus DDT. Highest yield was obtained in the plots dusted with copper-zinc nitrodithioacetate plus DDT followed closely by Tribasic copper sulfate, zinc nitrodithioacetate, Zerlate and Dithane Z-78 to all of which DDT was added as the insecticide.

Insect control in the dust plots (table 2) follows much the same pattern as in the spray plots. Aphid control on the whole was better with dusts than with sprays, with control of the older insects remaining about the same. Control of flea beetle with a combination of DDT and Chlordane was much better in the dust plots as compared with the same materials as a spray. Aphid control with Parathion remained high in the dust plots, and 5 per cent DDT also gave satisfactory control of this insect.

A second plot of mixed varieties was used in testing copper-zinc chromate (35 per cent early blight defoliation), compared with copper 8-quinolinolate (40 per cent) and DDT alone (70 per cent). The results with copper-zinc chromate dust are in keeping with those of the material as a spray. These materials were not included in the other series of dust plots because of lateness of arrival of materials. Only four applications of dust were made in these plots, and no insect counts nor yield records were made.

Summary

Further trials of combinations of fungicides and insecticides were made at the Lake City Experiment Station, using 22 sprays and 11 dusts. An average of 100 gallons of spray and 40 pounds of dust were used per acre at ten-day intervals.

All of the spray and dust combinations gave 95 to 100 per cent control of potato flea beetles. Control of aphids varied from 12 to 100 per cent in the spray plots and from 69 to 95 per cent in the dust plots. Although none of the materials gave 100 per cent of six-spotted leafhoppers, spittle bugs, tarnished plant bugs or potato leafhoppers, none of the mentioned insects nor the Colorado potato beetle presented

any serious problem during these tests. It is indicated that better control of the six-spotted leafhoppers was obtained with higher concentrations of DDT.

Early blight was first found on the 3rd of August; but was not present in serious amounts until the 24th. No late blight was present. In the spray plots, Copper zinc chromate, Zerlate, Yellow cuprocide, Dithane D-14, Cuprous oxide (H. H. Robertson Co.), were outstanding in early blight control. In the dust plots, Zerlate, Copper zinc chromate, Copper 8-quinolinolate, Tribasic copper sulfate, Dithane Z-78 and Zinc nitrodithioacetate gave very good early blight control.

There was no significant difference in yields from the dust plots In the spray plots, Zerlate, Zinc nitrodithioacetate, Dithane D-14, Parzate and Micronized cuprous oxide (C & H), ranked high in yields.

A second plot of mixed varieties was used in testing certain dust materials. Early blight readings showed that best control of this disease was obtained by the use of copper zinc chromate, 35 per cent defoliation, as compared with copper 8 quinolinolate 40 per cent, and DDT alone with 70 per cent. The results with copper zinc chromate dust are in keeping with those from the spray plots receiving this material as the fungicide.

EFFECT OF SOURCE OF POTASH IN THE FERTILIZER ON YIELD AND STARCH CONTENT OF POTATOES

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Muriate and sulfate of potash are the most common forms in which potassium is supplied to crops from commercial fertilizers. Other less common forms include double sulfate of potash-magnesia, manure salts, potassium metaphosphate and potassium nitrate. The effects of these various chemical sources of potash, particularly of the muriate. or chloride, and sulfate on crop yield and quality have been investigated

[1]Agronomist, Maine Agricultural Experiment Station. The author wishes to acknowledge the part J. A. Chucka, Arthur Hawkins, B. E. Brown, Stanley Junkins, Michael Goven and others had in the Maine experiments. Much of the work was in cooperation with the Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture.

Appreciation is extended to growers on whose farms the cooperative experiments were conducted.

extensively for many years. In fact, the literature on the effect of source of potash alone would fill a large volume.

No attempt is made here to review all of the literature on source of potash. Instead, the reader is referred to literature reviews by Hartwell (4), Schuster (7) and Sweetman (8).

As early as 1887 Scovell reported that in Kentucky the chloride source of potash produced slightly higher yields of potatoes than did the sulfate. A few years later Voorhees (1895) in New Jersey and Jenkins (1896) in Connecticut reported similar results. These and other investigators during this period either reported no difference in the effect of chloride and sulfate on the starch content of potato tubers or a higher content resulting from sulfate. Shiver (1901) also reported a reduction of starch in sweet potatoes fertilized with chloride, as compared with sulfate.

More research on the effect of source of potash on potatoes has been done in Germany than in any other country. Numerous papers have been published in European journals since about 1920. Results of these investigations invariably show that sulfate produces a higher starch content of the tubers than does chloride. Similar results have been reported from Great Britain. Houghland and Schricker (1933) concluded from work done in Virginia that potash fertilizer caused a slight depression in the starch content of the Irish Cobbler variety, which was greater for the chloride than for the sulfate source.

The starch content of potato tubers has been found by most investigators to be closely related to the dry matter content and fairly closely related to mealiness. Most people consider that mealiness constitutes high quality in cooked potatoes, other characteristics being satisfactory. A few, however, prefer potatoes to be somewhat waxy or "soggy" when cooked. Because of this difference in opinion, source of potash will be discussed only in relation to yield and starch content, leaving the matter of quality to be decided by the reader.

In much of the early experimental work on starch in potatoes actual determinations of starch were made. Some investigators estimated the starch content from the specific gravity of the tubers. In 1937 the German workers Von Scheele, Svensson and Rasmusson reported a very close relationship between the specific gravity of tubers and their starch and dry matter content. Since that time specific gravity, as determined by the Archimedes method of weighing the tubers in air and water or by immersing in brine solutions, has been largely used to calculate the starch content of potato tubers.

Source of Potash Experiments in Aroostook County

Effect of Source of Potash on Yields. The effect of the chemical source of potash in the fertilizer for potatoes has received considerable attention in Maine for many years. The possible effects on yield and quality were the two most important considerations.

Results as to the effect of chloride, sulfate and other sources on yield have been largely inconclusive. In some experiments and in some years slightly higher yields have resulted from the chloride. In others the sulfate has given slightly higher yields. As an average of all experiments conducted over the period of 1930-1944 and 1947-1948, the yields from the chloride and sulfate sources are practically the same. In experiments including the potassium nitrate or phosphate sources, their effect on yield was similar to that of the sulfate. Having part of the potash in the fertilizer as chloride and part as sulfate has usually resulted in yields intermediate between or similar to those obtained with either source alone.

The data in table 1, part of which is given in another publication (1), summarize experiments over the 1930-1944 period on fertility plots at Aroostook Farm, Presque Isle, Maine. In table 2 results from co-operative tests conducted in 1939-1941 are given. The Green Moun-

Table 1.—*Effect of chloride and sulfate sources of potash on Green Mountain potatoes,* 1930-1941.[1]

Year and Type of Rotation[2]	All from Chloride (KCl) Source	All from Sulfate (K_2SO_4) Source	Increase for Sulfate
Plots cropped every year to potatoes:			
Yield, Bus. per acre,			
1930-1936	364	364	0
1942-1944	428	404	-24
Plots in a potato, oats, clover rotation:			
1930-38,			
Yield, Bus. per acre	383	389	6
Starch content, per cent	16.1	17.8	1.7
Yield of starch, lbs. per acre	3700	4155	455
1939-44,			
Yield, Bus. per acre	384	381	-3

[1]The 1930-1941 data are taken from Chucka, *et al.* (1).
[2]Fertilizer was applied to all plots at the rate of 2,000 pounds of 4-8-7 in 1930-1938, and 4-8-8 in 1939-1944 per acre.

tain variety was grown in all of these tests except on the Easler Farm in 1940, where Katahdins were grown. The data in table 3 summarize the 1942 and 1943 experiments. Data presented are averages for the Chippewa, Green Mountain and Sebago varieties in 1942 and for the Green Mountain and Sebago varieties in 1943. Results from the 1939-1943 experiments for individual years are discussed in other publications (2).

In order to study the possible effect of source of potash on the need of potatoes for nitrogen in the fertilizer, rather extensive experiments were resumed in 1947 and 1948. With a potato planter now available with a specially designed fertilizer belt for applying small experimental lots of fertilizer accurately, it was thought that more consistent results might be obtained. Well replicated experiments in these years, however, failed to answer the question of effect of source of potash any more satisfactorily than had the previous experiments.

TABLE 2.—*Effect of source of potash on potato yields,* 1939-1941.

Year and Location of Tests	All from Chloride (KCl) Source	Yield—Bushels per Acre[1]		
		½ from Chloride, ½ from Sulfate	All from Sulfate (K_2SO_4) Source	⅓ Each from Chloride, Sulfate and Nitrate
1939 Tests:				
Blackstone Farm	378	375	363	375
Emery Farm	279	284	277	279
1940 Tests:				
Easler Farm	393	415	413	421
Fletcher Farm	323	342	364	338
1941 Tests:				
Duncan Farm	399	402	406	404
Fletcher Farm	330	356	340	352
Average, above 6 tests	350	362	360	362

[1]Yields for the ½ chloride and ½ sulfate treatment are for 2,000 pounds of 4-8-10 only; other yields are averages for 2,000 pounds of 4-8-8, 4-8-10, 4-8-12 and 4-8-16 per acre. Differences between potash sources were not significant.

In 1947 (9) sulfate of potash for the Green Mountain variety resulted in a significant increase of 34 bushels per acre over the chloride. For the Katahdin variety in the same experiment, there was no difference in yield between the two sources. (Table 4). In 2 other experiments in this year Katahdins yielded slightly higher with sulfate than chloride, but in 2 other experiments the reverse was true.

In 1948 both Green Mountains and Katahdins yielded slightly less

in an experiment with sulfate than with chloride. (Table 4). This was also true for Katahdins in a second experiment, but in a third chloride was slightly better. The average differences were not significant.

As an average for all experiments conducted, there is practically no difference in the yield of potatoes fertilized with chloride or sulfate of potash. As indicated above, results have not been very consistent and their explanation is not clear. No apparent consistent relationship between differences in yield from chloride and sulfate and the season, variety, previous crop, nitrogen fertilization or location can be detected in the yield data. In regard to the effect of season, Garner, *et al.* (3) found that fertilizing tobacco with muriate of potash materially increased the commercial value of the crop, as compared with sulfate, in drought years by increasing the water content of the leaf and making the crop more resistant to drought. This higher content of water in the foliage of potatoes fertilized with muriate has been noted in the Maine experiments, but its relationship to yield does not appear to be consistent.

Effect of Source of Potash on Starch Content. As contrasted to the variable effect of source of potash on yield of potatoes, as described in the previous section, muriate of potash has consistently resulted in a lower specific gravity and starch content of the tubers than have other sources.

Actual starch determinations were made on the Green Mountain potatoes grown on the fertility plots at Presque Isle from 1930-1938. As shown in table 1, the average increase in starch content from the sulfate compared with the chloride source of potash was 1.7 per cent. This amounted to an increase in yield of starch of 455 pounds per acre, an increase of approximately 12 per cent. The content of nitrogen in the tubers fertilized with sulfate was also slightly higher.

Starch content of the potatoes from experiments conducted in 1939-1941 and 1943 was not determined. In the 1942 experiments the starch content of the tubers was estimated from specific gravity determinations. As an average for the Chippewa, Green Mountain and Sebago varieties grown on 2 farms (Table 3), tubers grown with the sulfate source of potash contained 1.0 per cent more starch than those grown with chloride. The corresponding average increase in yield of starch was 200 pounds per acre, or slightly more than 6 per cent. The starch content of tubers grown with potash one-half from chloride and one-half from sulfate was intermediate. The content in tubers from plots fertilized with a combination of the nitrate and phosphate sources was similar to that in tubers from the sulfate plots.

TABLE 3.—*Effect of source of potash on potato yields and starch content, 1942-1943.*

Year and Location of Test[1]	All from Chloride (KCl) Source	½ from Chloride, ½ from Sulfate	All from Sulfate K_2SO_4 Source	Approx. ½ from Nitrate and ½ from Phosphate
1942 Tests:				
Cook Farm—				
Yield of tubers—Bus. per acre	531	533	533	536
Content of starch—per cent	11.9	12.5	12.7	12.7
Yield of starch—Lbs. per acre	3790	4000	4060	4080
Kitchen Farm—				
Yield of tubers—Bus. per acre	324	324	310	289
Content of starch—per cent	13.6	14.2	14.9	14.5
Yield of starch—Lbs. per acre	2640	2760	2770	2510
1943 test:				
Cook Farm—				
Yield—Bus. per acre	490	507	507	504
Ave. yield for above 3 tests—Bus. per acre	448	455	450	441

[1]Data are averages for 3 varieties in 1942 and 2 varieties in 1943. Fertilizer was applied to all plots at the rate of 2,000 pounds of 5-8-12 per acre. A yield difference of 22 bus. per acre was significant in the 1942 test on the Kitchen Farm. Other yield differences were not significant.

Results on Green Mountain and Katahdin varieties in 1947 and 1948 are similar to those obtained in 1942. As shown in table 4, the average increase in starch content of tubers from sulfate plots in 4 experiments was 1.0 per cent in 1947 and 1.1 per cent in 1948 compared with the tubers from chloride plots. Corresponding increases in the yield of starch were 350 and 295 pounds per acre, respectively.

The noticeably higher starch content of Green Mountain than of Katahdin tubers is also shown in table 4. The average difference in starch for both sources of potash on comparable plots amounted to 2.6 per cent in 1947 and 1.5 per cent in 1948. From these differences it may be seen that variety is a more important factor in starch content of potatoes than is source of potash. As an average of variety tests at 6 locations in Maine in 1948 (5), the starch content of the tubers, estimated from specific gravity determinations, was in the following decreasing order in the named varieties compared: Green Mountain, Mohawk, Irish Cobbler, Kennebec, Katahdin, Ontario and Chippewa.

TABLE 4.—*Effect of chloride and sulfate sources of potash on yield and starch content of potatoes, 1947-1948.*

Year and Location of Tests	Variety	Yield of Tubers—Bus. per Acre			Content of Starch—Per cent			Yield of Starch—Lbs. per Acre		
		Chloride Source	Sulfate Source	Increase for Sulfate	Chloride Source	Sulfate Source	Increase for Sulfate	Chloride Source	Sulfate Source	Increase for Sulfate
1947 tests:[1]										
Aroostook Farm—										
Annis field	Green Mt.	484	518	34	15.0	15.6	0.6	4365	4850	485
	Katahdin	512	512	0	12.2	13.2	1.0	3750	4055	305
Fertility plots	Katahdin	460	451	-9	13.4	14.6	1.2	3700	3950	250
Barnes Farm	Katahdin	470	486	16	—	—	—	—	—	—
English Farm	Katahdin	456	467	11	13.4	14.4	1.0	3665	4035	370
Griffin Farm	Katahdin	502	493	-9	—	—	—	—	—	—
Average for 1947		481	488	7	13.5	14.5	1.0	3870	4220	350
1948 tests:[2]										
Aroostook Farm—										
Fertility plots	Green Mt.	521	509	-12	15.6	17.4	1.8	4875	5315	440
	Katahdin	404	390	-14	14.4	15.6	1.2	3490	3650	160
Banks Farm	Katahdin	667	652	-15	12.8	13.8	1.0	5120	5400	280
Barnes Farm	Katahdin	612	621	9	13.0	13.6	0.6	4775	5065	290
Average for 1948		551	543	-8	14.0	15.1	1.1	4565	4860	295

[1]The 1947 values are averages for 2000 pounds of 4½-9-9, 6-9-9 and 7½-9-9 per acre.
[2]The 1948 values are averages for 2000 pounds of 4½-9-9, 4½-9-12, 6-9-9, 6-9-12, 7½-9-9 and 7½-9-12.

The cause of the lower starch content of a given variety fertilized with muriate than with sulfate of potash has been attributed by numerous investigators to the chlorine taken up by the potato plant. The effect of chlorine on the drought resistance of tobacco has been noted above, although fertilization of this crop with high rates of muriate usually results in poorer burn and a general reduction in the quality of smoking tobacco. Muriate of potash similarly causes a higher content of water in potato tubers and an accompanying lower content of starch and dry matter. The chloride content of potato foliage and tubers is also much higher when muriate is used.

As was true for the yield of potatoes in the Maine experiments, no consistent effect of the kind of season on starch content of the tubers, in relation to the source of potash, could be detected. Findlay (1928), however, observed that in Scotland fertilizing with sulfate of potash resulted in tubers of superior texture, as compared to chloride, especially in wet seasons or regions. Different varieties, with the same fertilizer treatment, tend to vary in starch content between locations and regions, and these variations are still largely without a satisfactory explanation.

Effect of Source of Potash on Tuber Discoloration. Certain varieties, especially Green Mountain and Irish Cobbler, are susceptible to a darkening of the stem-end portion of the tuber, known as stem-end browning. This browning was found by Ross, *et al.* (6) to occur in Green Mountain tubers fertilized with both muriate and sulfate of potash. The percentage of tubers affected, however, was considerably higher with chloride than with sulfate as the source. Recommendations to reduce the prevalence of stem-end browning in susceptible varieties include the use of fertilizer low in chloride and a reduction in the amount of potash applied, where such reduction does not cause lowered yields.

Summary

Experiments on the effect of source of potash in the fertilizer for potatoes were conducted in Aroostook County, Maine, over the period of 1930-1944 and 1947-1948.

As an average for all experiments muriate, or chloride, and sulfate of potash resulted in practically the same yield of tubers. In certain experiments and years the sulfate resulted in slightly higher yields, and in others the yields from chloride were slightly higher. In experiments where a difference resulted, yields from a combination of the phosphate and nitrate sources were similar to those from sulfate.

Sulfate of potash consistently resulted in higher starch content of

the tubers and a higher yield of starch per acre than did chloride. This difference ranged from 0.6 to 1.8 per cent starch and increases in yield of starch from approximately 200 to 450 pounds per acre.

The variety of potato was found to be a more important factor affecting starch content of the tubers than was the source of potash.

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METHODS FOR JUDGING FLAVOR AND ODOR OF COOKED POTATOES FROM SOILS TREATED FOR WIRE WORM CONTROL

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With the introduction of new pesticides, reports are being received of undesirable flavors in vegetables grown in the treated soils. In cooperation with the Department of Entomology of the New York State College of Agriculture, the Departments of Food and Nutrition and of Institution Management of the New York State College of Home Economics at Cornell University have been testing odor and flavor, after cooking, of potatoes that have been grown on soils treated with chemicals having insecticidal properties. The effect of several methods of cooking is being studied. As this same problem is being encountered by entomologists in many parts of the country, a description of the procedures seems desirable. The choice of procedures was based on previous years of experience with potatoes and on preliminary tests, in the spring of 1948, of the odor, and flavor, after cooking, of potatoes grown on soils treated for wireworm control.

SELECTION OF SAMPLES

For these studies, plots on which the control was high or complete were selected for sampling. This resulted usually, in samples from two or three plots each treated with a specified chemical at different levels of application. To test the possible effect of soil type as well as treatment, plots from each of two types of soil were also chosen for sampling. The samples were divided into two groups, each containing one check and six treated samples. The seven samples from one group were judged on the same day. This was about the maximum number that could be "handled" at one time, that is, prepared, served, and judged while hot, with available equipment and judges.

COOKING METHODS

The methods of cooking were chosen after consideration of the properties of the chemicals used for the soil treatments and of the practicality of the methods under home and institutional conditions. The final choice of methods comprised boiling in salted water, steaming at atmospheric pressure, steaming under 15 pounds pressure, baking, scal-

loping, and french frying. The initial preparation for each method, except baking, was the same. Sunburned or badly damaged potatoes were discarded.

Boiling. Three potatoes from each plot were pared, eyed and blemishes were cut out, and the pared potatoes were let stand in cold water until all lots were ready for cooking.

Only large potatoes were cut in half. Each lot was dropped into a two-quart saucepan containing two cups of boiling water and one-half teaspoon of salt. Each pan was covered and the water kept boiling until the potatoes were considered cooked when tested with a fork, usually about 40 minutes. The water was poured off, and the potatoes were broken up and well mixed with a wire potato masher. They were served in the pans in which they were cooked.

Steaming. Each lot of pared potatoes was dropped on a rack in a pressure saucepan containing two cups of boiling water and one-half teaspoon of salt. The pan was covered and the water kept boiling until the potatoes were considered cooked. Occasionally it was necessary to replenish the boiling water in the pans. A pressure saucepan used in this manner resembles a free-venting steamer. The cooked potatoes were mashed like the boiled ones and served in the pans in which they had been cooked.

For steaming under pressure, each lot of pared potatoes was dropped into a pressure saucepan containing one cup of boiling water and one-half teaspoon of salt. The lid was put on each pan, and the directions of the manufacturer were followed for the cooking of potatoes, allowance of time being made for the size of the potatoes. When cooked, the potatoes were mashed and served like the boiled ones.

Baking. Each potato was scrubbed and set on the table top until all were ready for cooking. Five lots of potatoes were baked in one oven and two (benzene hexachloride treatment) in another. To distinguish the different lots, a colored toothpick was inserted into each potato, a different color being used for each lot. The potatoes were baked in ovens at 425°F. until done as judged by testing with a fork. This usually took 50 to 60 minutes. The potatoes were cut into small pieces with scissors and served unsalted in heated glass dishes.

Scalloping. Pared potatoes were sliced crosswise with a slot peeler, each lot separately, and dropped into cold water until all lots were ready. The slices from each lot were thoroughly mixed and lifted out of the water, drained for a few minutes in a wire sieve, and then put into a one-quart glass casserole in layers alternating with a standard medium white sauce made with a bland fat. Enough sauce was used to cover the

potatoes. The same volume of sauce and the same quantity of potatoes were used for all lots. The potatoes were cooked in ovens at 350°F. until done, usually for one hour. They were served in the dishes in which they had been cooked.

French frying. The pared potatoes were cut into strips lengthwise by forcing them through a metal grid with holes one-half inch square. The strips of potatoes from each lot were put into a bowl of cold water until all were ready. They were then drained and dried on towels. For each lot of potatoes one pound of cooking fat was heated to 365°F. in a one-quart saucepan. The strips were dropped into the fat, about 20 at a time, and cooked until a light brown. They were drained on paper towels and served in hot glass casseroles. The judges were supplied with salt to shake over their samples as desired.

Judging Methods

The judging and the cooking were done in the same room. A service counter separated the judging area from the preparation area. Tables and chairs were provided. On the service counter were placed pencils and score sheets, dinner plates and forks, and all the samples to be judged. The pans or dishes in which the samples were served were numbered for identification. For all methods except french frying, numbered souffle cups were provided. For french fried potatoes, dinner plates were numbered around the rim. A self-service procedure was used, each judge taking from the counter a pencil, a score sheet, a fork, and an adequate amount of each sample. It was customary for the judges to test the odor of the potatoes in the service dishes because only small samples were taken for taste testing.

The score sheet was of the check type, and for each sample the judges were asked to check one of the following descriptive terms for both odor and flavor: natural; off-odor (or off-flavor)—weak, medium, strong. The judges were also asked to check whenever they considered the odor or flavor to be objectionable.

The group of judges consisted of faculty members, graduate students, and clerical employees from the three departments cooperating in the study. The judging was timed for 10:15 or 10:30 a. m. three days a week, and those of the group who were available constituted the panel of judges for the day. Consequently, the panel varied in composition and number from day to day. Little effort was made to prevent conversation, but each judge was asked to record his own unbiased opinion. No training was given and the identity of the check sample was unknown to the judges.

The order of presentation of the samples was changed from time to time but not in a truly random manner. Each group of samples included two from soils treated with benzene hexachloride. As experience had shown that such samples often imparted an after-taste that obscured the flavor of samples tasted shortly thereafter, benzene hexachloride samples were always given the highest numbers of the day and the judges were asked to taste the samples in numerical order.

The samples for each week's tests were brought into the laboratory either on Friday of the preceding week or on Monday of the same week. They were selected from the plot yields in storage by the professor of entomology in charge of the insecticide experiments. After receipt in the test kitchen they were stored in the vegetable compartment of a household refrigerator because no other low temperature storage facilities were conveniently available. The samples from plots treated with benzene hexachloride were stored in a separate refrigerator.

Discussion

The foregoing method of judging odor and flavor of cooked potatoes is debatable on several points. If, however, these are considered in relation to the procedure as a whole and to past experience, arguments can be advanced in their favor. Some of the points are:

Small number of potatoes used in each cooking lot. Practical experience with larger numbers of potatoes had led the experimenters to conclude that any off-odor or off-flavor due to soil treatments was to be found in all potatoes from a given treatment. Consequently the number was cut to that which could be handled conveniently within the general framework of the experiment.

Use of only approximate weights of potatoes in each sample. Use of accurately weighed amounts of potato would have necessitated trimming one or more of the potatoes or cutting the potatoes into small pieces and weighing a sample. The latter method was not used because it is not common home practice, and neither the former nor the latter method was used because the extra labor involved would not increase the accuracy of the experiment.

Use of only an unknown check sample. Some experiments with both a known and an unknown check sample showed that the ability of the judges to distinguish between natural and off-odors and flavors was not increased by the presence of a known check sample. To decrease labor and increase the number of treated samples that could be judged daily the check sample was limited to an unknown.

Conditions of judging. There is extensive literature on subjective

scoring of foods and the effect of variables such as environmental conditions, composition of judging panel, and training of judges. It is not pertinent to review this here. Some of the problems are discussed in the references listed. It is seldom pointed out that an experimenter frequently has to organize a panel of judges from volunteers who have other, and sometimes more pressing, calls on their time. It is often as important to maintain the interest and good will of the judges as to increase their efficiency in what is to them a minor activity. If a piece of work must be done, the worker uses the best skill and the most efficient tools at his command. This study was considered sufficiently important to warrant its procedure without delay under the best available conditions of judging.

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SECTIONAL NOTES

Indiana

With our reduced acreage in Indiana this year, we are finding that the yields are greatly increased over previous seasons because of our climatic conditions and also the absence of any blight damage. Our commercial harvest has always been on the upland soils, mainly Irish Cobblers. The size is very good, there is very, very little evidence of scab and practically all our growers are continuing to spray up until the time of harvest. The Early Cobblers appear to be running between 500 and 600 bushels of No. 1 Grade to the acre, with very few over-size potatoes. The market is taking the potatoes nearly as fast as they are harvested and the price is quite fair.

Our main crop, or late potatoes, is in excellent condition also. We have wonderful vine growth, no evidence of any disease or insect troubles and these growers are putting on a spray once a week to keep away any damaging or disastrous effects that may result in weather changes. We have a most promising outlook in Indiana and our growers seem quite happy regarding the situation. W. B. Ward.

Maine

Aroostook County has had an excellent growing season to date. Many people are remarking that we should have one of the best crops ever. The July estimate of 40 bushels per acre seems to bear this out. The August 10th estimate is eagerly awaited. E. L. Newdick, Chief of Bureau of Plant Industry, reports that the rejections under the certified seed program have been very small. No blight has appeared in any area of Aroostook County to date, which is most uncommon.

Aphids have made their appearance during the last week despite the fact that every one is using DDT. Many of the aphids apparently are potato aphids, which are more resistant to DDT than the other species.

Farmers are beginning to talk about early harvesting. Indications are that the roto beater and the roto cutter will be used to a large extent, although it is expected that several types of sprays will be used. Last year practically all of the methods of killing tops except the roto beater and cyanamid caused internal discoloration. Although it is apparent that this was a major factor in the fall, only a few lots would not pass U. S. inspection in the spring.

Every one is still looking for a satisfactory potato combine but as yet apparently none has been developed which can satisfactorily handle Aroostook's tops and rocks.—Verne C. Beverly.

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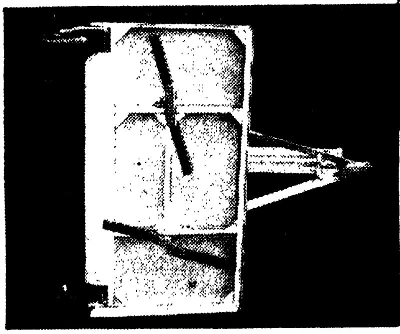

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NEBRASKA

The next annual High Plains States Potato Workers' Conference will be held at Alliance and Scottsbluff, Nebraska, on the 9th and 10th of September. Headquarters for the meeting will be the Alliance Hotel, Alliance, Nebraska. This conference will be built around informal meetings at the hotel and the inspection of experimental work being conducted under dry-land conditions at the Box Butte Experiment farm and under irrigation at the Scott's Bluff Experiment Station. We plan to discuss problems involved in the release of new varieties, new developments in disease and insect control, the merits of vine killing and root-cutting with respect to late potatoes, foundation seed programs and the certification of seed potatoes. In the field extensive breeding and variety adaptation tests will be exhibited along with experiments concerned with the control of leaf roll disease and insects. Results obtained in scab tests, fertilizer and rotation experiments are also expected to be shown and should attract considerable interest. Although this is primarily a conference of workers from Colorado, Wyoming and Nebraska, many specialists from other states have been attending. We now wish to assure all potato workers regardless of where they live that they will be heartily welcome. ROSCOE E. HILL.

NEW JERSEY

The potato crop in New Jersey is approximately 25 per cent harvested. All the Cobblers and most of the Chippewas have been dug. Many growers are now harvesting their Katahdins. The yield of Cobblers was slightly higher than estimated on the first of July and many fields of Chippewas and Katahdins will yield 65 to 75 per cent of a normal crop. However, there are many fields that will not produce 50 per cent of a normal crop. Irrigated fields will produce from 2 to 3 times as many potatoes as our non-irrigated ones.

The excessive heat during June and July caused many tubers to sprout in the fields, and sprouts have formed on 25 to 75 per cent of the tubers, depending upon soil type and the use of irrigation. Most severe sprouting has been noted on the lighter soil types or on the gravelly knolls where soil temperatures became excessively high. Where irrigation water was applied early enough and continued at regular weekly intervals, there is less sprouting than in fields where irrigation was not started until the 10th or 15th of June or applied at 10 to 12-day intervals between applications. The sprouts range in length from 1/32" to 5" and numerous sprouts have emerged through the soil and established sturdy plants. Growers are doing an excellent

job of removing these sprouts at the grader. In most instances the quality of our crop is good.

A marked difference in the amount of sprouting in varieties was noted on the 5th of August when the writer and Dr. Henry A. Jones, Horticulturist at the U. S. Department of Agriculture, inspected a variety test at Cranbury. These differences will be observed carefully when the test is harvested. J. C. CAMPBELL.

NEW YORK

The acreage of certified seed in New York State is about the same as it was last year. Most varieties with the exception of two are maintaining their relative positions in regard to popularity. Chippewa has decreased 25 per cent in acreage and Essex has increased approximately 560 per cent. It now stands above Chippewa, Green Mountain, Irish Cobbler, and Ontario in popularity. This is one of the few new varieties that has been widely accepted throughout the state.

The weather has been and continues to be an important subject among potato growers. From my personal observations in upstate New York I don't believe that the dry season has been as much of a detriment as many believe. Of course, I don't expect yields to compare with last year's ideal conditions, but I do feel we will get fair yields.

Virous disease counts have been quite low through first inspection, and consequently very few yields have been rejected. JOHN MACABEE.

OREGON

The acreage of certified seed as applied for this year is 900 Russets and 450 White Rose. Because of the late spring frost the crop is very late, therefore the first field inspection was delayed. A long full growing season will improve the situation.—C. A. HENDERSON.

PROVINCE OF ONTARIO

The 1949 Prize List for the Royal Winter Fair, Toronto, Ontario, Canada, is now available. Copies may be secured free upon request to the above address.

Eight classes for seed potatoes are provided, and all varieties that are officially accepted under Potato Certification Regulations are eligible. Provision is made for thirty-one prizes in each class with first prizes up to thirty dollars in cash. A solid gold watch, donated by The American Potash Institute will be awarded to the exhibitor winning the Grand Championship. Ribbons will be provided for Championship and Reserve Championship exhibits. This major potato show will be held

in the Colesium, Exhibition Park, Toronto, from the 15th to the 23rd of November.

In table stock potato classs, eight additional classes are listed, with eleven prizes in each class and twelve dollars as first prize in each case. The Championship will be fifty dollars in cash and Reserve Championship will be twenty-five dollars in cash, both donated by Gray-Snyder Company, Ltd., Hillsburg, Ontario, manufacturers of potato pickers. Thirty potatoes will constitute an entry in each class of seed or table stock, and trays are provided for exhibit purposes.

Although competition is open to the world, it is expected that all the Provinces in Canada, and many of the principal potato-producing areas of the United States will send a substantial number of exhibits. United States exhibitors should write Customs Department, Royal Agricultural Winter Fair, Toronto, Canada, for proper forms and shipping instructions to facilitate customs entries. It is important that intending exhibitors give this matter immediate attention in order that exhibits be admitted without collection of duties. Entries will close October 26, 1949.

The potato show at the Royal Winter Fair, has been enlarged during recent years and attracts much attention. It is now recognized as an outstanding display, not only from the standpoint of number of exhibits, but excellent quality. During the past two years, two well known potato authorities from the United States have served as judges in the persons of H. J. Evans, Manager, New York Seed Potato Growers Co-operative, Georgetown, N. Y., and Prof. E. V. Hardenburg of Cornell University, Ithaca, N. Y. Last year, exhibitors from Ontario won 136 prizes and the Grand Championship, whereas the Reserve Championship went to British Columbia. R. E. GOODIN.

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INVESTIGATIONS ON WIREWORM CONTROL WITH ORGANIC INSECTICIDES IN NEW JERSEY*[1]

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(Accepted for publication May 1, 1949)

Wireworms have long been a serious limiting factor in the production of high quality potatoes and other crops. Prior to World War II control measures were limited to various cultural practices, many of which could not be employed on a practical basis, and soil fumigants, which were too costly for practical field use. During and immediately following the war there appeared several synthetic organic compounds that had exceedingly high insecticidal action and long residual action against many species of insects, On the basis of available information on these compounds it was believed that some of them might have value as soil insecticides to control wireworms. Accordingly, in 1945 experiments were initiated to determine their value as controls for these important pests.

The studies by Pepper *et al* (1946 and 1947). Greenwood (1947) and Post *et al* (1947) showed that benzene hexachloride in relatively small quantities per acre gave excellent control of wireworms attacking

potatoes. The same treatments as reported by Pepper *et al* (1947) were applied to market garden soils which were planted to cabbage, cauliflower, celery and onions with comparable wireworm control. These studies were continued in 1947 and 1948 by the writers. Several additional chemical compounds have been tested since 1946. The purpose of this paper, therefore, is to summarize our investigations to date.

Field Experiments in 1947

The data from tests made in 1945 and 1946 showed a high degree of control from the use of technical benzene hexachloride at dosages ranging from 0.5 to 10 pounds of gamma isomer per acre. In the same tests DDT and its analogs used at much higher rates gave poor wireworm control generally. It was decided, therefore, to place emphasis on benzene hexachloride dosage rates, methods of applications, time of applications, comparison of technical with purified grades and to test the value of parathion, chlordan, chorinated camphene and ethylene dibromide. In the case of benzene hexachloride, tests were made on several different farms for the purpose of determining the effect of soil type on toxicity to wireworms.

Dosage Experiments with Technical BHC. — A series of plots were set up to determine the minimum dosage of benzene hexachloride required to control wireworms. Each treatment was replicated four times on plots 50 feet by 50 feet square. Samples of tubers for wireworm counts and yield records were taken from the centers of the plots on 1/100 of an acre area per replicate. The technical material was diluted with talc in proportions to give the desired rate of the gamma isomer in 200 pounds of the mixture applied per acre. All materials were mixed in a power driven dust mixer. A wheelbarrow type fertilizer and lime spreader was used to distribute the powdered material after the land was plowed in the spring. After application the plots were thoroughly disked. This experiment was repeated on three different farms. The results are presented in table 1.

As pointed out in previous reports, the yields have been significantly higher in the plots treated with benzene hexachloride than in those receiving other treatments. The data in table 1 show that 0.5 lb. of gamma isomer is about the minimum effective dosage. Greenwood (1947) and

*Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University, the State University of New Jersey, Department of Entomology.

[1]Mr. C. A. Wilson assisted with these studies in 1947.

[2]Entomologist, Research Associate in Entomology.
[3]Assistant Research Specialist, Plant Pathology.

TABLE 1.—*Dosage rates of technical benzene hexachloride*—1947.

Gamma Isomer Dosage per Acre	Yield per Acre	Number Tubers Examined	Number Tubers Infested	Per cent Tubers Infested
	Bushels			
Tests at Hightstown, N. J., Katahdin variety				
.13 lbs.	557.7	3764	79	2.09
.26 lbs.	511.0	3483	50	1.44
.52 lbs.	530.2	3775	38	1.01
1.04 lbs.	577.7	4090	11	0.27
2.08 lbs.	550.6	3543	2	0.06
Check	430.0	3039	290	9.54
Tests at Freehold, N. J., Katahdin variety				
.13 lbs.	530.4	2633	67	2.54
.26 lbs.	503.6	2204	41	1.86
.52 lbs.	531.3	2490	5	0.20
1.04 lbs.	555.1	2683	5	0.19
2.08 lbs.	547.4	2635	3	0.11
Check	466.4	2302	168	7.30
Tests at Mount Holly, N. J.,* Cobbler variety				
23 lbs.	413.1	1652	234	14.16
.42 lbs.	449.2	1768	165	9.33
.90 lbs.	448.8	1770	39	2.20
Check	413.1	1836	370	20.15

*Standard lime spreader used.

Post *et al* (1947) obtained effective control with approximately 0.2 pound gamma isomer per acre.

Experiment on Method of Application. — In our 1946 experiments the results showed that hand and power driven dusters gave poor distribution of the material and the question arose as to the best method of applying the insecticides. An experiment was set up for the purpose of determining the best method of distributing the materials and also to determine whether the toxicant could be mixed with fertilizer and applied broadcast. The procedure followed in this test was essentially the same as that followed in the dosage test previously described. Each treatment was replicated four times on plots 50 feet by 50 feet square. The same dosage level was used on all plots, namely 0.5 pounds of gamma isomer per acre derived from the technical grade material. The dry materials were mixed in proportions to give the desired level of the toxicant in 200 pounds of the mixture. Talc was used as the diluent except in the case of the fertilizer plots. A 5-10-5 fertilizer was used in this case and the benzene hexachloride was added and thoroughly mixed with a shovel on a concrete floor. The regular dust mixture was mixed in a power dust mixer. In the spray plot the technical grade

benzene hexachloride was suspended in water in proportions to give 0.5 pound of the toxicant in 100 gallons of water. The spray was applied at the rate of 100 gallons per acre with a power sprayer using an orchard type spray gun.

All pieces of application equipment were calibrated to give the desired dosage. The results of this experiment are presented in table 2.

TABLE 2.—*Experiment on methods of applying technical benzene hexachloride at level of* 0.5 *pounds of gamma isomer per acre.*

Treatment	Yield per Acre	Number Tubers Examined	Number Tubers Infested	Per cent Tubers Infested
	Bushels			
Tests at Hightstown, N. J., Katahdin variety				
Hand duster	564.3	3856	104	2.70
Hand distributor	590.2	3940	34	0.86
Hand distributor—fertilizer	544.2	3845	68	1.77
Grain drill	594.2	4030	18	0.45
Spray	540.0	3769	10	0.27
Hand distributor—plowed under	544.2	3811	258	6.77
Check—no treatment	532.7	3643	370	10.16
Tests at Freehold, N. J., Cobbler variety				
Hand duster	476.0	2136	52	2.43
Hand distributor	456.0	2219	11	0.49
Hand distributor—fertilizer	486.2	2090	29	1.39
Grain drill	442.4	2432	13	0.53
Spray	435.2	1954	19	0.97
Hand distributor—plowed under	446.3	2071	48	2.32
Check—no treatment	456.4	2102	168	7.99

As noted in table 2 the number of injured tubers was much higher where the benzene hexachloride was applied by a hand duster or where it was plowed under. Also there was some increase in the number of injured tubers when the toxicant was mixed with fertilizer.

In supplementary tests it was found that when benzene hexachloride was applied in spray form on land covered with debris and plowed under or harrowed in the results were poor. Other tests were conducted where the dry material was applied over a cover crop of grain and poor control resulted. In these cases apparently the insecticides generally stick to the cover crop material or debris on the surface and do not become thoroughly incorporated in the soil.

Observations indicate that when dust applications are made with a power duster the insecticide does not necessarily fall where it is directed and an uneven distribution results.

Experiments on Time of Application. — After observing the amazing results from tests in 1946 the question arose as to the best time

to apply benzene hexachloride for effective control of wireworms. It would seem logical for a potato grower to observe carefully the location of wireworm infestations as the potato crop is harvested and to treat only the infested area immediately thereafter provided the treatment would be effective on the next year's crop. In order to ascertain this information an experiment was devised wherein plots were treated after the potatoes were harvested in the fall of 1946 and other plots received a similar dosage of the same formulation in April 1947. The same plot arrangements were employed as described in the above-mentioned experiments. After the plots were staked out and the fall treatments applied the soil was thoroughly disked and seeded to cover crop. In the spring, the field was plowed and the spring applications were made to the proper plots after which the land was disked and planted to potatoes. In addition to the problem on time of application the question arose regarding the effect of applications on the foliage of growing plants in connection with tuber infestations. Since benzene hexachloride was used in spray and dust experiments for the control of foliage feeding insects, tuber samples from these plots were compared with those from untreated plots and those receiving calcium arsenate for wireworm injury. The data from these tests are presented in table 3.

TABLE 3.—*The effect of time and method of application of technical benzene hexachloride on wireworm control.*

Treatment	Yield per Acre	Number Tubers		Per cent Tubers Infested
		Examined	Infested	
	Bushels			
Sept. 1946—0.5 lbs. gamma isomer	421.7	636	4	0.63
Sept. 1946—1.0 lbs. gamma isomer	432.0	711	6	0.84
April 1947—0.5 lbs. gamma isomer	436.5	654	5	0.76
April 1947—1.0 lbs. gamma isomer	442	725	4	0.55
Check	386	692	254	36.71
Spray—0.25 lbs. gamma isomer*	—	225	5	2.22
Dust —0.25 lbs. gamma isomer	—	225	6	2.67
Check	—	225	80	35.56

*8 applications of spray and dust made on these plots beginning in early June and continued at weekly intervals for 8 weeks, giving a total of approximately 2 pounds of gamma isomer per acre for the season.

It is noted in table 3 that there is no apparent difference between fall applications and spring applications of benzene hexachloride to the soil. Even the spray and dust applications to the growing plants gave

a marked reduction in tuber injury but were not so effective as the soil treatments.

Experiment on Effectiveness of Different Insecticides. — An experiment was conducted to determine the value of deodorized benzene hexachoride, toxaphene, parathion, chlordan and ethylene dibromide in comparison with the technical benzene hexachloride. Unfortunately, it was not possible to use all of the materials in the same field. Some of the materials were not available when the grower planted the field where it was originally planned to make the test. The ethylene dibromide treatments were applied in September, 1946, on acre plots duplicated in two separate fields. The other materials were tested on 50x50 feet square plots replicated four times. Untreated checks and with technical benzene hexachloride were located in each field for comparison.

The data from these experiments are set forth in table 4.

TABLE 4.—*A comparison of different insecticides applied to the soil for wireworm control*—1947.

Treatment (Figures represent active ingredients per acre)	Yield per Acre	Number Tubers Examined	Number Tubers Injured	Per cent Tubers Injured
	Bushels			
Deodorized BHC 0.5 lbs. gamma isomer	483.2	2153	16	0.74
Deodorized BHC 1.0 lbs. gamma isomer	492.3	2084	8	0.38
Technical BHC 0.5 lbs. gamma isomer	497.3	2360	34	1.44
Chlorinated camphene 8 lbs.	449.7	2149	90	4.19
Parathion 5 lbs.	467.5	2211	110	4.97
Check	460.4	2302	168	7.30
Chlordan 4 lbs.	490.8	2079	393	18.90
Chlordan 8 lbs.	490.8	1801	149	8.27
Technical BHC 0.5 lbs. gamma isomer	537.2	2136	17	0.80
Check	369.2	1665	345	20.72
Ethylene dibromide 2 gallons	357.5	685	26	3.79
Technical BHC 0.5 gamma isomer	421.7	625	5	0.80
Check	394.2	729	112	15.36
Ethylene dibromide 2 gallons	418.3	885	11	1.24
Ethylene dibromide 2.3 gallons—sprayed*	428.2	681	48	7.05
Technical BHC 0.5 lbs. gamma isomer	438.3	842	4	0.47
Check	386.7	1029	271	26.34

*The ethylene dibromide-naphtha mixture was emulsified with "Tween 80" and sprayed on the surface of the soil with a power driven potato sprayer, immediately after which the soil was thoroughly disked.

With the exception of the ethylene dibromide which is a liquid, all the other materials were in dust form and were diluted with talc so that by using an application rate of 200 pounds per acre the required dosages of toxicant were obtained. The ethylene dibromide used was a mixture of 1 part ethylene dibromide to 9 parts of naphtha by volume supplied by the Dow Chemical Company. Except for the spray plot the other two plots were applied with an injection apparatus loaned by the Dow Chemical Company.

The deodorized benzene hexachloride is reported to be a purified material containing approximately 90 per cent gamma isomer. A supply was received from the California Spray Chemical Corporation and the Niagara Division of the Food Machinery Corporation under the trade names of "Isotox" and "Hi-Gam" respectively.

The chlordan used was a 40 per cent concentrate supplied by Sherwin-Williams Company.

The chlorinated camphene was a 50 per cent concentrate supplied by the American Cyanamid Company. This company also supplied the parathion as a 15 per cent wettable powder.

The data in table 4 show that the two grades of benzene hexachloride and the ethylene dibromide were the only materials that gave a reasonably high degree of control. However, the 8 pounds of chlordan reduced the injury by about 60 per cent. Parathion and chlorinated camphene were only slightly effective at the dosages used.

These same materials were used on a heavily infested market garden soil on which cabbage and cauliflower were planted. Here the ethylene dibromide was applied in the bottom of the plow furrow as the land was plowed. A can with a spout connection was used to apply the liquid in the furrow bottom at the desired dosage. In this case the wireworm mortality was approximately 100 per cent, using the same dosage as used on potato soil.

D-D mixture was also used on the market garden soil at 10 and 20 gallons per acre with results inferior to those with ethylene dibromide. The cost of the D-D mixture application was 2 to 3 times that of ethylene dibromide and it also required much longer to disappear from the soil.

The parathion, benzene hexachloride, chlorinated camphene and chlordan gave about the same order of control as shown in the potato experiments, table 4.

Field Experiments in 1948

The question of the effects of the different treatments on the flavor and quality of the tubers in the 1947 experiments was confusing and

uncertain and it was decided to place emphasis on this problem in 1948. The experiments were limited to two locations in 1948 and every precaution was exercised to prevent possible contamination from one treatment to another. The sites selected for the tests were fairly level and treatments were made only when the wind was favorable in order to prevent the blowing of the dust materials from one plot to another.

One series of experiments was located at East Freehold and the other at the College Farm, New Brunswick, where the writers had complete control. Plots 25 feet wide by 40 feet long were employed and each treatment was replicated three times. The materials were mixed in a power driven dust mixer in concentrations to give the desired dosage of toxicant when an application rate of 200 pounds of dust per acre was used. All applications were made with the hand-operated fertilizer distributor. At East Freehold the grower followed the regular spray program for foliage insect and disease control. At the College Farm the foliage sprays were limited to three applications of rotenone for insect control, the purpose being to minimize the possibility of interfering with taste and odor of tubers by a regular spray program. Unfortunately, foliage feeding insect damage was severe and the yields at New Brunswick were very low in comparison with the commercial plantings. The wireworm control data in the two experiments were so closely parallel that, for brevity, only the data from the College Farm experiment are presented in table 5. This table gives not only the materials used but also the yields and tuber infestation obtained.

It will be noted from table 5 that the yields were somewhat erratic. This may be accounted for in part by the fact that the growing season was very wet and cultivation was limited by wet soil. As a result some areas were overrun by weeds. Also, soil fertility probably accounts for part of the irregularity.

There is some evidence that certain of the materials tend to suppress yields whereas others tend to increase them. Chlorinated camphene as shown in the 1947 experiments and in table 5 above tends to reduce the yield. On the other hand, it has been noted in nearly every test that benzene hexachloride appears to stimulate yield.

It is interesting to note that parathion at 10 and 20 pounds per acre gave excellent control of wireworms, whereas the 5-pound rate was insufficient both years. It also appears to result in increased yields.

Chlordan has not performed so well in our tests as informal reports from other investigators have indicated. However, 8 and 16 pounds

TABLE 5.—*A comparison of varying dosages of insecticides and different insecticides.*

Treatments—Amount Actual Toxicant per Acre	Yield per Acre	Per cent Tubers Infested
	Bushels	
Deodorized BHC 0.125 lbs. gamma isomer	119.7	3.8
" " 0.250 " " "	118.0	3.9
" " 0.5 " " "	142.1	2.4
" " 1.0 " " "	141.0	0.2
Technical BHC 0.5 " " "	165.2	0.3
Pure gamma BHC 0.25 " " "	134.8	2.1
" " " 0.5 " " "	162.7	0.9
" " " 1.0 " " "	107.8	2.6
Chlordan 2 lbs.	113.3	7.9
" 4 lbs.	111.0	4.8
" 8 lbs.	163.0	1.5
" 16 lbs.	140.0	1.0
Parathion 5 lbs.	118.0	6.1
" 10 lbs.	128.0	0.8
" 20 lbs.	195.0	0.3
Chlorinated camphene 25 lbs.	122.4	3.2
" " 50 lbs.	76.4	0.9
Check	131.9	12.5

The pure gamma isomer has a melting point of 112.6-113.8° C., supplied by General Chemical Company. The identity of other materials in table 5 is given in the 1947 experiments.

per acre gave good control in 1948 in our tests, but the 8-pound rate gave only 60 per cent reduction in infestation in 1947.

Tests in 1947 and 1948 indicate that there is little or no difference in the toxicity between technical, deodorized or pure gamma isomer of benzene hexachloride provided the dosages of gamma isomer are equal.

RELATIONSHIP OF TREATMENT TO QUALITY

Because of the strong musty persistent odor of technical benzene hexachloride it was surmised from the beginning that it might affect the flavor or quality of tubers. As reported in 1946 there was some off-flavor but it was detectable by only a small percentage of individuals. In 1947 conditions were somewhat different. Although samples from our experimental plots did not give a clear-cut picture, potatoes from some commercially-treated fields were severely affected.

All of the quality testing work at this station in 1947 and 1948 was done by Dr. Walter A. Maclinn and associates in the Food Technology Department.

Potatoes from the ethylene dibromide plots appeared to be free from any off-flavor due to the treatments,

In addition to taste tests, bioassays have been run on the same samples using mosquito larvae as the test organism. No toxicity has been noted in any of the samples. Chemical analyses have been made but they are inconclusive. The only chemical treatment that has given satisfactory wireworm control and is absolved from the possibility of imparting off-flavor is ethylene dibromide which should be applied during the fall preceding the potato crop.

The taste tests on sample of tubers grown in 1948 gave results that appear to have some significance. The tests for potato tubers grown in 1948 on soils treated in 1947 are summarized in table 6. The data show that the tubers from the treated plots were comparable with those of the check, indicating that the strong taste of technical benzene hexachloride is greatly reduced or eliminated after being in the soil for a year.

Table 7 summarizes the data obtained from tubers grown in soils that had been treated just prior to planting. Technical benzene hexachloride resulted in definite off flavors in the tubers whereas those grown in plots treated with refined and pure gamma isomer benzene hexachloride were much less offensive. Chlordan gave slightly less off-flavor than benzene hexachloride, whereas the parathion treatments were the least offensive of all, comparing quite well with the check.

TABLE 6.—*Summary of taste tests on tubers grown in* 1948 *on soils treated in* 1947.

Material	Dosage Range Lbs./Acre	No. Times Sampled	Per cent Times Reported as		
			Off	Flat	Pleasing
Technical BHC*	0.13 - 0.52	92	19.5	31.5	50.0
Technical BHC*	1.04 - 2.08	92	20.7	39.1	40.2
Check	-	62	27.4	35.5	37.1

*Dosage expressed as gamma isomer.

General Discussion and Summary

The research conducted in New Jersey with the new synthetic organic insecticides has demonstrated that benzene hexachloride, chlordan, parathion and ethylene dibromide are effective in controlling wireworms. The data also show that it requires approximately 0.5 pounds of gamma isomer for effective control where large populations of the insect are present. Smaller dosages may give control under low popu-

TABLE 7.—*Summary of taste tests on tubers grown in 1948 on soils treated just prior to planting.*

Material	Dosage Range Lbs./Acre	No. Times Sampled	Per cent Times Reported as		
			Off	Flat	Pleasing
Technical BHC*	0.25 - 0.50	36	69.5	16.6	13.9
Refined BHC*	0.125 - 1.0	118	31.0	22.0	46.0
Pure g.i. BHC*	0.25 - 1.0	29	34.5	44.8	20.7
Chlordan	2 - 16	106	28.3	26.4	45.3
Toxaphene	25 - 50	79	20.3	40.5	38.2
Parathion	5 - 20	33	15.1	33.3	51.5
Check	-	36	11.1	25.0	63.9

*Dosage expressed as gamma isomer

lation conditions. DDT, TDE and chlorinated camphene have failed to give adequate control in most cases even at rates of 25 to 50 pounds per acre.

Chlordan at 8 or more pounds per acre has shown promise, but appears to have the same disadvantages as benzene hexachloride from the standpoint of producing off-flavors which in some instances were very objectionable.

Parathion at 10 to 20 pounds per acre resulted in good wireworm control and very little off-flavor was found when tubers from treated areas were compared with tubers from untreated plots, or with those from areas treated with any form of benzene hexachloride or chlordan. The relatively high cost may limit its use, should it be found on further investigation to be safe to use.

At the present time there is no chemical treatment within reasonable cost range that can be safely used on potatoes to control wireworms, except ethylene dibromide. Even with this latter compound there is need for improved methods of applications.

It is possible that some of the insecticides which have been found to result in the least off-flavor may find a place in the potato program by treating wireworm-infested soils a year previous to the planting of potatoes. In order to prove this point, much more research work needs to be conducted.

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CANUS: A NEW POTATO VARIETY ADAPTED TO ALBERTA AND OTHER SECTIONS OF THE DOMINION OF CANADA

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ORIGIN

The Canus variety of potato, U.S.D.A. Seedling 41914, is not so well adapted as Katahdin, Chippewa, and several others to the potato-growing sections of the United States, but has shown so much promise in tests in Alberta and other sections of the Dominion of Canada that it has been increased and distributed to growers in that country. It is one of the results of cooperative work that has been carried on between the two countries for a number of years.

The variety is a hybrid first grown on the Aroostook Farm, Presque Isle, Maine, in 1921 when Dr. William Stuart was in charge of potato investigations for the United States Department of Agriculture and Dr. C. F. Clark was leader of the potato-breeding work. As part of the work of the National Potato-Breeding Program a relatively large number of seedlings have been sent to Canada by the United States Department of Agriculture, and Canada has reciprocated by sending varieties and species to the United States.

Canus is of hybrid origin and so is the name—"Can" for Canada and "us" for United States.

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Canus originated from a cross between Greeley Seedling 9-11 and U.S.D.A. Seedling 25642.

The pedigree follows:

Canus, U.S.D.A. Seedling No. 41914	U.S.D.A. Seedling No. 24642	Sutton's Flourball
		Aroostook Wonder
	Greeley Seedling No. 9-11	Villaroela
		Selfed

Greeley Seedling No. 9-11 was a selection from a selfed line of the South American variety Villaroela, made by C. F. Clark when he was engaged in potato-breeding work at the Potato Experiment Station, Greeley, Colorado.

Sutton's Flourball was an English variety according to Stuart (3). Aroostook Wonder was identical with the American Giant, and according to Clark and Lombard (1) American Giant is a synonym of White Rose. The Aroostook Wonder is therefore the White Rose.

Description

Plants. — Medium in size and spreading; stems medium-thick and prominently angled; nodes slightly swollen and green; internodes reddish purple; wings straight and green; stipules medium in size, green, and glabrous; leaves medium to long, broad open, and medium green; midribs green and scantily pubescent; primary leaflets ovate, medium in size, three pairs; mean length of blade 61.51 ± 0.58 mm. (2.42 inches), mean width 34.19 ± 0.36 mm. (1.35 inches), index 55.64 ± 0.35; leaflet petioles green; secondary leaflets medium in number, having two positions on midrib, between primary leaflets and at junction of midrib and petiole of primary leaflet; tertiary leaflets none; inflorescence medium-branched and leafy bracts few; peduncles short to medium, green, and scantily pubescent; pedicels medium length, pigmented, medium pubescent.

Flowers. — Calyx lobes long, green, and scantily pubescent; corolla medium in size (29-31mm.), white tips and mauvette; anthers orange yellow; pollen scant and poor quality; styles straight; stigma globose, multi-lobed, and green.

Tubers. — Roundish oblong, somewhat flattened; mean length 84.79 ± 0.83 mm. (3.34 inches); mean width 80.18 ± 0.73 mm. (3.16

inches); mean thickness 57.71 ± 0.58 mm. (2.27 inches); indexes, width to length 94.95 ± 0.90, thickness to width 72.11 ± 0.64, thickness to length 68.51 ± 0.91; skin smooth, creamy white; eyes not numerous, shallow; flesh white; maturity medium-early.

The plant description was made by Robert V. Akeley, Presque Isle, Maine; the tuber measurements and calculations were made at the Plant Industry Station, Beltsville, Maryland; and the leaf index was calculated by dividing the width of each of 100 leaflets by their length, and multiplying the average of these ratios by 100. The leaflets were taken from the fourth leaf from the top of the stem; one leaflet, the distal left lateral, was taken from each leaf. Since the potato leaflet is asymmetrical, the length was determined by taking the average of the measurements from the apex to the base of each respective lobe. This is a modification of the method described by Salaman (2), (see pages 163-170).

Tuber measurements were taken on 85 potatoes grown on Aroostook Farm, Presque Isle, Maine, each weighing approximately 8 ounces (224.05 ± 5.02 gm.). The same measurements were used to calculate the three indexes: width to length, thickness to width, and thickness to length. The index for width to length was calculated by dividing the width of each tuber by its length and multiplying the average of the 85 ratios by 100. The other indexes were calculated by the same methods.

Characteristics

From 1932 to 1936 Canus was tested rather extensively in the United States as part of the National Potato-Breeding Program. Tests were made in Florida, Iowa, Kansas, Louisiana, Maryland, Mississippi,

Table 1.—*Yields of Canus in comparison with three standard varieties at the Dominion Experimental Station, Lacombe, Alberta.*

Year	Canus		Netted Gem		Irish Cobbler		Chippewa	
	Yield per Acre	Marketable	Yield per Acre	Marketable	Yield per Acre	Marketable	Yield per Acre	Marketable
Tested	Bus.	Pct.	Bus.	Pct.	Bus.	Pct.	Bus.	Pct.
1939	264	88	217	64	215	84	235	95
1940	403	95	352	50	318	97	352	90
1941	392	90	366	69	314	82	402	79
1942	463	94	423	78	509	80	466	88
1943	332	96	338	93	240	90	356	97
1944	458	90	385	86	304	77	568	77
1945	565	83	387	73	500	81	519	83
Average	411	91	353	73	343	84	414	87

Michigan, New Jersey, New York, North Carolina, North Dakota, Ohio, Rhode Island, South Dakota, and Virginia. It was promising in a number of these tests but did not seem to be as widely adapted as Katahdin and Chippewa with which it had to compete. Consequently, it was not increased for distribution in the United States. That it was selected in preference to other seedlings in Alberta is not surprising, for frequently a variety may be inferior in one part of the country and superior in another.

In Alberta, Canus is a medium-early variety that produces a high yield of uniform tubers, a high percentage of which are marketable. The vines are medium in height and the stalks are coarse and upright in habit of growth. The leaves are medium in size, rather short and rounded in shape, and of a normal green shade; the tubers are roundish-oblong, somewhat flattened; the eyes are not very numerous and are shallow; the buds are green, tinged with violet; there are only slight depressions at the seed and stem ends; the skin is smooth and creamy white; the flesh is white and has a well-defined starch line; the baking

TABLE 2.—*Yields of Canus in comparison with other varieties of potatoes at various locations throughout Canada.*

Year Tested	Location	Canus		Irish Cobbler		Chippewa	
		Total Yield per Acre	Market-able per Acre	Total Yield per Acre	Market-able per Acre	Total Yield per Acre	Market-able per Acre
		Bus.	Bus.	Bus.	Bus.	Bus.	Bus.
1946	O.A.C., Guelph,	410	393	310	295	337	320
	University of Manitoba	317	285	310	284	286	
1947	O.A.C., Guelph,	307	243	299	256		
	University of Manitoba	638	537	744	576	664	237
1938	Prince George, B.C.	268	211	266	205		511
	Lacombe, Alta.	503	489	613	514		
	Scott, Sask.	475	398	275	165		
	University of Manitoba	630	554	532	464		
	Fort William, Ont.	211	202	178	166		
	O.A.C., Guelph,	317	274	280	232		
	Smithfield, Ont.	266	234	327	193		
				Green Mountain			
	St. Clothilde, P.Q.	725	686	543			
				Green Mountain			
	Bradford, Ont. (muck land).	546	493	498	450	Netted Gem 492	406

quality is excellent, and it boils dry and mealy. The resistance of the variety to disease has not been definitely established but pathologists report the seed stocks at present as "being free from virus diseases, scab, and blackleg."

The yield data for Canus in comparison with those of Netted Gem, Irish Cobbler, and Chippewa for a period of 7 years at the Dominion Experimental Farm, Lacombe, Alberta, are given in table 1. Canus outyielded Netted Gem and Irish Cobbler, but not Chippewa.

Under irrigation in southern Alberta, Canus has yielded 667 bushels per acre. It finds favor in that area as it is a midseason variety fitting between the Irish Cobbler and Netted Gem seasons.

Canus has done well on heavy clay soils of Manitoba, but in tests in 1946 it did not significantly outyield Irish Cobbler, with which it would have to compete, in any of six commercial areas of that province.

In a number of other tests at various locations in Canada, Canus has shown promise. It has outyielded the standard varieties in nearly all these tests, as can be seen in table 2.

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THE COMPARATIVE LENGTH OF DORMANT PERIODS OF 35 VARIETIES OF POTATOES AT DIFFERENT STORAGE TEMPERATURES

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The length of time that different varieties of potatoes will remain dormant in storage is of practical and scientific interest to plant breeders and commercial storage operators alike. The fact that different varieties

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vary in the length of their dormant periods at any one temperature was shown in 1934 in the U. S. Department of Agriculture Technical Bulletin 424.[1] In that publication an attempt was made to show separately the rest period and dormant period of the varieties studied. It was stated by way of definition "There is some confusion as to the meaning of the terms dormant period and rest period. In this discussion the term rest period in potato tubers refers to that period immediately following harvest during which they will not sprout even when kept under favorable growing conditions. Under the same conditions at the end of this rest period growth activity evidenced by the production of sprouts becomes apparent. On the other hand, if potatoes are held at a temperature too low for sprout growth they will remain in a dormant condition . . ." The dormant period in that discussion and in the present one is defined as the total period in which potatoes remain without sprouting within given storage conditions irrespective of the rest period. The previous publication, of course, dealt only with varieties grown at that time and some of these are now out of commercial production. Since that time a considerable number of new varieties have been introduced and some of these have already come to be of commercial importance.

The investigation reported herewith was begun in 1945 to study some of these newer varieties as well as certain seedlings under test, along with some old varieties still of importance. These were held at temperatures usually found in ordinary storage and handling operations. This investigation was continued during the normal winter storage seasons of 1945-1946, 1946-1947, and 1947-1948. The 53 varieties studied included five unnamed seedlings. All of these were grown in Aroostook County, Maine, by specialists of the Potato Investigations section of this Bureau. They were grown on a uniform type of soil, thus affording a direct varietal composition without the complicating influences of various growing conditions. Each season the potatoes were harvested approximately the last week in September. They were held a few days in a cool bank storage at about 60°F. until a railroad refrigerator car-lot, including other material, was assembled and sent under standard ventilation to the Beltsville laboratory. Approximately three weeks elapsed between harvest and final storage. On arrival the different varieties were each apportioned into lots of 18 uniform sized tubers and these were stored at constant temperatures of 70°, 60°, 50°, and 40° with a relative humidity of 85 per cent at each temperature. At one-week intervals each lot was examined until more than seventy-five per cent of the tubers showed a definite initiation of sprout growth.

In the following table is given the average number of weeks required by each variety of potatoes to show the initiation of sprouting while held continuously at these temperatures. This period includes the three weeks between harvest and the beginning of controlled storage. Where "+" follows a value in the table it signifies that the lot was still dormant when observations were discontinued for that season.

An examination of the results reveals little difference in dormancy at 70°F. and at 60°, the average difference in time being only about a week. With certain varieties there was a difference of two to three weeks, between lots held at 60° and 50°, whereas in other varieties the difference in sprouting time at these temperatures was greater. The average difference was about six weeks. It should be noted that the Potomac variety which at 60° sprouted at about the same time as many of the other varieties, never sprouted at 50° during the three seasons of the test. The difference in the dormant periods at 50° and at 40° was proportionally greater than between the higher temperatures—amounting to an average of 17 or more weeks. In 40° storage a number of varieties, including the Chippewa, Erie, Irish Cobbler, Katahdin, Pontiac, Potomac, Sebago, Sequoia, and seedling 47258, did not sprout while under test during one or more seasons. Each season the tests at this temperature were run much later than there should be any practical need to store potatoes. Varieties with comparatively short dormant periods at 40° were Calrose, Cayuga, Earlaine, Earlaine 2, Golden, Kasota, Pawnee, Russet Rural, and Rural New Yorker. The Golden had the shortest dormant period at 40°. Sebago, which did not break dormancy at 40° during the tests, ranked with the varieties having shorter dormant periods at the higher storage temperatures; whereas the Mohawk, Russet Burbank, and White Rose showed relatively long dormancy at 70°, 60°, and 50°, and a relatively short period at 40°.

Discussion

Since potatoes from storage at the relatively high temperature range from 50°F. to 60° are more suitable for immediate use because of their lower sugar content than those from lower temperatures, it is of advantage to storage operators to know the varieties that remain dormant for the maximum period of time within this temperature range. Selecting 14 weeks as an arbitrary dividing line between relatively "long-keepers" and "short-keepers" at 50°, we see that the varieties remaining free from sprouting for 14 weeks or longer include Erie, Green Mountain, Irish Cobbler, Katahdin, Kennebec, Mohawk, Pontiac, Potomac, Russet Burbank, Sequoia, Teton, White Rose, and No. 47258. This

TABLE 1.—*Number of weeks required by 35 different varieties of potatoes to sprout when stored at 70°, 60°, 50° and 40° F. during three storage seasons*

Variety	1945-1946				1946-1947				1947-1948				Approximate Varietal Average			
	70°	60°	50°	40°	70°	60°	50°	40°	70°	60°	50°	40°	70°	60°	50°	40°
Calrose	—	—	—	—	5	7	9	25	5	7	9	23	5	7	9	24
Cayuga	—	—	—	—	7	7	11	28	7	7	9	23	7	7	10	25
Chippewa	7	7	11	27	7	7	11	43	9	9	13	38	8	8	12	36+[1]
Earlaine	7	7	11	23	7	9	11	28	9	9	11	27	8	8	11	26
Earlaine 2	5	7	11	23	5	7	9	26	7	7	9	25	6	7	10	25
Erie	5	7	15	35	5	7	11	43+	7	7	13	38+	6	7	13	39+
Golden	5	5	7	11	5	5	7	9	—	—	—	—	5	5	7	10
Green Mountain	7	9	17	33	7	9	11	30	11	11	17	35	8	10	15	33
Houma	7	7	15	27	7	7	11	28	9	9	9	27	8	8	12	27
Irish Cobbler	7	9	15	27	9	9	11	26	9	9	13	38	8	9	13	30
Kasota	7	7	11	25	7	7	11	24	9	9	11	25	8	8	11	25
Katahdin	7	9	17	43	7	7	11	39	9	9	11	38+	8	8	13	40+
Kennebec	—	—	—	—	—	—	—	—	9	9	19	38+	9	9	19	38+
Menominee	7	7	13	27	5	5	11	26	7	7	11	38	6	6	12	30
Mesaba	7	9	11	25	7	9	11	28	7	7	11	33	7	8	11	29
Mohawk	9	11	17	29	9	9	11	27	9	9	13	25	9	10	14	27
Norkota	5	7	11	25	7	7	11	26	9	9	9	33	7	8	10	28
Pawnee	7	7	13	23	7	9	11	28	7	7	11	27	7	8	12	26
Pontiac	7	9	17	23	7	9	20	43+	9	9	17	38+	8	9	18	35+

TABLE 1. (Cont'd.)—*Number of weeks required by 35 different varieties of potatoes to sprout when stored at 70°, 60°, 50° and 40°F. during three storage seasons.*

Variety	1945-1946				1946-1947				1947-1948				Approximate Varietal Average			
	70°	60°	50°	40°	70°	60°	50°	40°	70°	60°	50°	40°	70°	60°	50°	40°
Potomac	11	13	43+	43+[1]	7	9	43+	43+	9	9	38+	38+	9	10	41+	41+
Red Warba	7	9	17	31	7	7	11	32	7	7	9	25	7	8	12	29
Russet Burbank	7	9	17	27	7	9	11	28	9	11	13	27	8	10	13	27
Russet Rural	9	9	15	25	9	9	11	26	9	9	11	25	9	9	12	25
Rural New Yorker	9	9	13	25	9	9	11	26	9	9	11	25	9	9	12	25
Sebago	5	7	11	43+	5	5	11	43+	7	7	11	38+	6	6	11	41+
Sequoia	7	9	15	33	7	7	13	39	9	9	17	38+	8	8	15	37+
Teton	7	9	23	43+	9	9	20	43+	7	7	17	38+	8	8	20	41+
Triumph	7	9	13	35	9	9	9	32	9	9	11	38	8	9	11	35
Warba	7	7	15	33	7	7	11	28	7	7	11	25	7	7	12	29
White Rose	7	13	17	25	7	7	11	28	11	17	17	27	8	12	15	27
24642	5	7	11	25	7	7	11	35	7	7	11	33	6	7	11	31
46952	7	7	11	25	7	7	11	35	7	7	11	25	7	7	11	28
47258	7	7	23	43+	7	7	20	43+	7	9	25	38+	7	8	23	41+
B61-3	—	—	—	—	—	—	—	—	7	9	9	25	—	—	—	—
B69-16	—	—	—	—	—	—	—	—	7	9	38+	38+	—	—	—	—
Approximate average of all varieties for each temperature.													7	8	14	31+

[1] + indicates that no sprouting was visible at termination of this particular storage test.

does not mean that most of the varieties that do not fall in this class and are classed as "short-keepers" cannot be used longer than 14 weeks. The values shown in the table simply indicate when sprouting began. After the initiation of sprouting the growth was usually relatively slow and the tubers were still usable for such processing as chipping, French frying, or dehydrating for four to six weeks thereafter, since the rate of sprout growth varied from only a trace to about one-sixteenth to one-eighth of an inch the first month after initiation at this temperature. At 40° the sprout growth as late as the last of June usually amounted at most to only a trace and was entirely lacking in many varieties.

The above facts are presented to show that, while there are wide varietal differences, the usable life of potato stocks at 50°F. is much longer than is commonly realized. Since potatoes held at this temperature are usually suitable for immediate use by processers without further conditioning, much time and expense in handling commercial stocks could be saved by manufacturers and those who supply hotels and restaurants. With the use of sprout inhibitors early in the storage period according to directions given by the manufacturers, the usable life of potato stocks at this temperature can be lengthened. Furthermore it is desired to emphasize to potato breeders that long-dormancy is an important factor to consider in any breeding program.

YAMPA, A NEW SCAB-RESISTANT POTATO

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AND

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ORIGIN

When the program of breeding potato varieties resistant to scab was begun, little was known regarding the existence of physiological races of the scab organism. Experiments with the physiological races

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of the scab fungus have shown that although many races are present in a given soil, a variety of potato resistant to one race is usually resistant to all. A few exceptions have been noted (1).

The development of potato varieties possessing desirable horticultural characters and having disease resistance and good quality has been difficult. The absence of scab-resistant, early-maturing parent material has added to the difficulty. Most scab-resistant seedlings have been late maturing. Several German varieties were shown to be highly resistant to scab. Two of these, Hindenberg and Richter's Jubel, were crossed with superior commercial varieties. Many new scab-resistant seedlings were produced and tested in uniform scab test plots conducted by the U. S. Department of Agriculture and cooperating State Agricultural Experiment Stations. Several seedlings were found to be resistant to scab in all places tested. All were late-maturing but possessed other characters that are desirable. Several of these have been named: Menominee in Michigan, by Wheeler, Stevenson, and Moore (3); Ontario, Seneca, and Cayuga in New York, by Blodgett and Stevenson (1).

From a limited number of the more promising scab-resistant seedlings, several were selected as parent material and used in crosses made at the U. S. Potato Station at Greeley, Colorado. A cross, U.S.D.A. Seedling 245-186 X Katahdin, produced a large number of desirable seedling varieties which were tested in scab plots located in most of the potato-growing areas of the United States. Several selections from this cross showed high scab resistance and other desirable characteristics. One of these selections, C.S. 6317, which has been named Yampa[a], was found to be as high yielding as standard varieties, scab resistant, of good shape on lighter soils, and to have good cooking quality.

Description

Plants, medium in size, erect; stems thick, prominently angled; nodes slightly swollen, green; internodes green; wings slightly waved, green; stipules small, in lowest peduncle, clasping. Leaves medium in length, broad, open type, light bluish-green; mean length of blade 57.71 + 0.35 mm. (2.27 inches)[a]; mean width 38.88 + 0.26 mm. (1.53 inches); index 66.93 + 36.[b] Midribs green, scantily pubescent; pri-

[a]An Indian name meaning "Little Bear," also the name of a mountain valley in northwestern Colorado where this variety was tested and increased.

[a]Calculations after method of Salaman, R. N. Potato Varieties. 378 pp. illus. Cambridge. 1926.

[b]Calculated by dividing the width of each of 100 leaflets by their length, and multiplying the average of these ratios by 100.

The pedigree of Yampa follows:

- Yampa, USDA Seedling No. C.S. 6317
  - Katahdin
  - USDA Seedling No. 245-186
    - Richter's Jubel
    - USDA Seedling No. 444-12
      - Earlaine
      - USDA Seedling No. 44537
        - Katahdin
        - Chippewa

mary leaflets medium in number, in two positions—on midrib between pairs of primary leaflets and at junction of midrib and petioles; tertiary leaflets few. Inflorescence little branched; leafy bracts none; peduncles medium in length to short, green scantily pubescent; pedicles short, little pigmented, abundantly pubescent.

Flowers: Calyx lobes long to medium in length, little pigmented, abundantly pubescent; corolla small (diameter 1 inch), white; anthers orange yellow shading to lemon yellow; pollen scant; style straight; stigma bilobed, green.

Tubers roundish, thick, mean length 85.21 + 0.39 mm. (3.35 inches)[c]; mean width 76.07 ± 0.43 mm. (2.99 inches); mean thickness 59.57 + 0.32 mm. (2.34 inches); mean indices: width to length 89.49 + 0.76; thickness to width 78.49 + 0.50; thickness to length 70.08 + 0.58. Skin slightly flaked in some soils, smooth in others, self-colored, varying from cream to buff, variation depending on type of soil; flesh white; eyes shallow, same color as skin; eyebrows not prominent, curved. Sprouts in diffuse light, light perilla, purple at base of sprout; body of old sprout highly colored; tip of leaf scales reddish; base of lateral leaf scales colored. Maturity medium early.

CHARACTERISTICS

Yampa is a medium early variety, maturing about 7 to 10 days after Bliss Triumph when grown under the same conditions.

The tubers are round to blocky, with shallow eyes and vary in color from white to light russet depending on the soil. They are classed as white in the commercial trade. Fig. 1 shows a Yampa tuber.

[c]Measurements based on 100 tuber sample of 8 oz. tubers.

FIG. 1 YAMPA TUBER

This variety has been grown in test plots located in practically all of the major potato-growing states. It was resistant to scab in all but two of these tests. More recent tests have shown Yampa to be infected with No. 4 type pustules in one area in Colorado and one in California. Observations and greenhouse tests indicate that there is a degree of resistance to leaf roll and mild mosaic. This variety appears to be somewhat resistant to tuber infection from late blight, but light infection of the leaves and stems has been noted. It is resistant to early blight, having only small lesions on the leaves; in no test has defoliation occurred as in the case of more susceptible varieties.

The cooking quality of Yampa is above average. The keeping quality is good under average conditions. In sandy soils the tuber skin has a tendency to become slightly russeted. The skin is firm and tubers do not show skinning injury or cracking at harvest. When grown in soils with high fertility it has a tendency to oversize, if spaced too far apart in the row; and in heavy soils considerable growth cracks develop. It sets deeper than Katahdin and therefore does not sunburn as readily.

Adaptation and Comparison

Most tests have been conducted in Colorado, where it has been grown in several of the scabby areas as a late crop and has produced good yields of marketable tubers in most places. When grown as an early variety in the scabby soils of Colorado, high yields of practically scab-free tubers have been produced. Table 1 shows the total yield, yield of U.S. No. 1 tubers, mean total yield, and per cent of culls due to scab in a field heavily infested with scab, at Gilcrest, Colorado, for the years 1945-1948 inclusive.

Bliss Triumph did not produce any No. 1 tubers in 2 of the 4 years of testing in this scab-infested soil. Most of the Bliss Triumph crop was marketed as U.S. No. 2 tubers because of scab in this plot. In 1945, 43.1 per cent were graded as culls because of scab, and in 1946, 37.6 per cent. Yampa did not significantly outyield Bliss Triumph in 1945, 1946, or 1948, but produced a higher percentage of U.S. No. 1 tubers than did Bliss Triumph. Table 2 shows the total yields of Yampa, other varieties, and several seedling varieties in 1946 at 7 places in Colorado, one in Wyoming, and one in Iowa. In all cases Yampa equaled or out-yielded the other varieties tested.

Table 3 indicates that the differences in total yield between Katahdin, C. S. 6317, Pawnee, Red McClure, C. S. 3175. Irish Cobbler, and Bliss Triumph were not great enough to be statistically significant at the 5 per cent level.

Table 3 also indicates that the difference in per cent (by weight) of U.S. No. 1 tubers over two inches in diameter was not great enough to be significant at the 5 per cent level between Katahdin, Pawnee, and Irish Cobbler. Yampa, 6316, Red McClure, 3175, Russet Burbank, and Bliss Triumph all gave a significant decrease in grade.

There was no significant difference in specific gravity.

Dissemination

The United States Department of Agriculture has no seed of the Yampa variety for general distribution. Certified seed growers in Colorado are increasing the seed stocks of this variety.

TABLE 1.—*Yield of Yampa and Bliss Triumph at Gilcrest, Colorado.* 1945, 1946, 1947, *and* 1948.

Variety	1945			1946			1947			1948			
	Total Yield Bus.per Acre	Per Cent U.S. No. 1 Tubers	Per Cent Culls Due to Scab	Total Yield Bus.per Acre	Per Cent U.S. No. 1 Tubers	Per Cent Culls Due to Scab	Total Yield Bus.per Acre	Per Cent U.S. No. 1 Tubers	Per Cent Culls Due to Scab	Total Yield Bus.per Acre	Per Cent U.S. No. 1 Tubers	Per Cent Culls Due to Scab	Mean Total Yield 4 Years
Yampa	708.2	92.8	0.0	642.7	95.4	0.0	828.6	97.	0.0	879.0	97.0	0.0	764.6
Bliss Triumph	679.3	0.0	43.1	584.6	0.0	37.6	751.1	60.	20.0	850.0	90.0	5.0	716.2
M.S.D. 5% level	91.0			62.0			74.3			68.9			

TABLE 2.—*Total yield in bushels per acre of Yampa and other varieties and seedling selections, at 7 places in Colorado, 1 in Wyoming, and 1 in Iowa, 1946.*

Variety or Seedling	Gilcrest, Colorado	WoodyCreek Colorado	Windsor, Colorado	Montrose, Colorado	Yampa, Colorado	La Porte, Colorado	Greeley, Colorado	Laramie, Wyoming	Crystal Lake Iowa
Yampa	642.7	408.5	286.5	423.0	598.2	372.6	365.9	307.2	459.0
C.S. 6316	551.7		203.2	293.3	384.4	319.4	346.6	255.5	428.0
C.S. 6332		414.3	245.8						
C.S. 6362			255.6	339.7	294.2				
C.S. 6344	627.2	375.6		343.6		325.2			
Bliss Triumph	584.6*							283.2*	
Pawnee			269.1*		484.0*		405.5*		
Irish Cobbler						265.5*			295.0*
Rural New Yorker				421.0*					
C.S. 3175	653.3	305.8	224.5	265.2	540.1	316.5	392.0		
Russet Burbank		319.4*							
M.S.D. 5% level	62.2	69.6	27.3	52.0	59.3	66.8	65.9	35.9	50.0

*COMMERCIAL VARIETY OF THAT LOCATION AT TIME OF TEST.

TABLE 3.—*A comparison between several potato varieties and seedlings at Fort Collins in* 1948.

Variety	Total Yield Bus. per Acre	Per cent U.S. No. 1's above 2 in. in Diameter	Specific Gravity
Katahdin	409	80.7	1.090
Yampa (C.S. 6317)	433	69.1	1.093
Pawnee	396	86.2	1.001
C. S. 6316	304	68.9	1.09
Red McClure	371	71.9	1.098
Russet Burbank	325	53.1	1.093
C. S. 3175	387	71.6	1.087
Irish Cobbler	413	79.7	1.084
Bliss Triumph	443	70.8	1.102
M.S.D. 5 per cent level	76	10.9	NS
M.S.D. 1 per cent level	102	8.1	

SUMMARY

The Yampa potato has shown considerable promise as a scab-resistant, good-quality, high-yielding variety. It has shown field resistance to scab, early blight, and to leaf roll and mosaic. It appears best adapted to the lighter mineral soils. It has a relatively tough skin and keeps well. Maturity is approximately 7 to 10 days later than Irish Cobbler or Bliss Triumph.

1. Blodgett, F. M., *and* F. J. Stevenson. 1946. The new scab-resistant potatoes: Ontorio, Seneca and Cayuga. Amer. Potato Jour. 23: 315-320.
2. Schall, L. A. 1944. Variation and physiologic specialization in the common scab fungus (*Actinomyces scabies*). Jour. Agr. Res. 69: No. 5
3. Wheeler, . . . J., F. J. Stevenson, *and* H. C. Moore. 1944. The Menominee potato, a new variety resistant to common scab and blight. Amer. Potato Jour. 21: 305-311.

SECTIONAL NOTES

Indiana

We are harvesting some of the best Katahdins, Chippewas, and Cobblers that we have ever harvested in the state. Our crop is clean, the size is good, and the potatoes are moving in large quantities almost as fast as they are being harvested. We are also enjoying good harvesting weather as it is not too hot, and the soil is fairly dry. Our yields are running from 400 to 600 bushels of No. 1's per acre, which is very good, and no one is complaining about the price. W. B. Ward.

Kentucky

Harvesting begun on the 11th of July, and is now complete, except for small lots over scattered areas. Ninety per cent were Irish Cobblers, with some Sequoia and a trace of Sebago. Although the latter two are specifically late varieties, test lots have behaved so well in the past few seasons that have been unusually wet, that growers have begun venturing to plant them as first crop, because of their fine appearance.

The early part of our season was rather wet, but just as settings-on started, came a drought of 26 days that affected Irish Cobbler (which is usually early enough to escape), and also reduced the acreage of Sequoia and Sebago drastically. The Irish Cobbler variety averaged 125-150 marketable bushels per acre, as against the usual 200 bushels—a great percentage of under-size tubers occurring. The quality was superior, however, and all No. 1 Cobblers moved well without assistance, only the "B-size" of the three varieties needed to be moved under the Marketing Act.—John S. Gardner.

Maine

Aroostook has had an excellent growing season. The drought which hit New England did not affect the county, and the excellent seed with plenty of fertilizer and little late blight indicates a yield of 400 bushels per acre which is the highest on record. Very few cases of late blight are apparent in the county. Aphids are present but in very small numbers as DDT has been used by all farmers regularly. Where aphids were numerous, Parathion has given excellent control.

In general, digging is expected to start about the 19th of September. Already farmers are starting to kill the tops with roto-beaters and sprays.

PMA records indicate that more than 99 per cent of all Maine growers stayed within their potato allotments this year.

Two potato meetings of particular interest to growers were the

Potato Blossom Festival, with Ralph Trigg, President of the Commodity Credit Corporation as speaker, and the Farm Bureau Field Day with Dr. Roger Corbett as speaker.

The Maine Experiment Station has recently issued three bulletins which are very timely and carry much helpful information; namely, Bulletin No. 470 by Drs. G. W. Simpson and W. A. Shands, entitled, "Progress on Some Important Insect and Disease Problems of Irish Potato Production in Maine; Bulletin 471 by Drs. Bonde and Schultz, entitled, "Control of Late Blight Tuber Rot;" and Bulletin No. 472 by William Schrumpf, entitled, "Practices, Costs, and Tuber Bruising in Digging Potatoes in Aroostook County, Maine."—VERNE C. BEVERLY.

NEBRASKA

The reports on the Nebraska potato crop have been scarce as the proverbial hen's teeth, because of the rush of other work. After things quieted down from the great blizzard of 1949, potato production has been on a very safe and sane basis.

The early crop of central and eastern Nebraska, on which harvesting has just been completed, was somewhat below the yields of the past seasons. In the Gibbon-Kearney district, yields were below those of a year ago, because of the extreme heat. In the area around Cozad, yields equalled those of the previous year, and in some cases exceeded 400 bushels per acre of very high quality. The central and eastern areas produce practically all the Red Warba variety, with just a few acres of Irish Cobblers still in the picture. A few varieties are being tried, with mediocre success, generally because of their lateness.

In the western part of the state, which is the late main crop, a number of troubles were encountered at planting time in June. Excellent conditions obtained at the beginning of the month, but a satisfactory period of a week to ten days followed on the 10th of June, which resulted in poor stands in many fields. At the beginning of the planting season, the entomologists reported excessive build-up of the psyllid insects, and warned growers to be on the alert to dust or spray potatoes immediately after emergence. This admonition was followed by a great many growers, however, a few doubting Thomases did nothing until psyllid damage appeared in their fields. This has proven to be one of the most serious outbreaks of psyllid damage since the trouble was recognized in this area. The last year comparable to this one was 1938. In most cases early patches of potatoes and tomatoes that were untreated, were a total loss.

Even though the summer has been above the average in tempera-

tures, the growth of the potatoes in fields, on both irrigated and dry land, is progressing satisfactorily. There have been occasional rains in the dry land areas, to carry the fields, but those fields are at a critical point now, and a general rain is needed to get good production on the dry land. Two serious hail storms have struck the western area of Nebraska, therefore the production of all crops in those sections will be materially reduced. Some crops, particularly beans, will be a total loss, and potatoes may be reduced as much as 75 per cent. Our irrigated acreage is progressing satisfactorily, barring an early blight epidemic.

The acreage entered for certification in Nebraska has dropped about 8 per cent compared with last year. This is the fourth consecutive year that a reduction in acreage has taken place in this territory. The variety "Progress," released to the industry a year ago, is being increased substantially, both under certification and in commercial acreage. Therefore, Nebraska is comparable to other states in introducing new varieties in production.—MARX KOEHNKE.

NEW YORK

Because of an occasional shower during the past month the outlook for the certified seed crop in New York State has improved to a great extent. It now looks as if we may get a fair yield. However, the size of the tubers may tend to be rather uneven. Aphid counts have been low and little blight has been found.

The second inspection is proceeding according to schedule and should be completed in approximately ten days.—F. JOHN MACABEE, *(Inspector)*.

The Crop

On the 5th of September we had a larger percentage than usual of green vines although we have had the hottest and driest summer in years. The set is light, especially in some sections, and the size is smaller than usual in many areas for this time of season. However, with green vines there is a possibility that material increases could be expected if rain and cooler weather come. In some areas the crop is good.

Varieties

This has been a good season to test new varieties for the resistance to heat and dry weather. Both Essex and Ontario have shown up well in this respect and give promise of crops considerably ahead of some of our standard varieties.

Seed

Second inspections have not yet been completed but there are in-

dications that the percentage certified will be higher than last year. The acreage was somewhat reduced. Yields will no doubt be reduced. To summarize, it looks as though our certified seed will be a little lighter than last year on the whole, and the size and quality much better because of weather conditions. Both insects and plant diseases have been kept under control.

Marketing Agreements

No definite steps have been taken but the committee is trying to find out if certain variations can be made to fit the Metropolitan conditions. There is considerable interest among potato growers and shippers. Nothing has been submitted in the way of a written agreement.

Prices

The few early potatoes that are now appearing on the markets are meeting with very good receptance and bringing a little more money than out-of-state potatoes. There are not enough being sold to establish a market, but apparently freshly dug up-state potatoes look better to the buyers than some of the more wilted potatoes reaching us from the southern areas.

Meetings

The next big meeting on the calendar is the Annual Meeting of the Empire State Potato Club held in connection with the New York State Vegetable Growers and the Weed Control people in New York, from January 3rd to 6th inclusive, at the Hotel New Yorker. Invitations are being sent to neighboring states and it is hoped that these meetings will be very well attended. The program committee is trying to work out a program that will be of interest to the whole area rather than to the state alone.

The Summer Field Meeting of the Potato Club was very well attended. The official count of cars was well over 9000.—H. J. EVANS.

OREGON

As of this date the 17th of August, we have finished our first field inspection, with 900 acres of Russets and 450 acres of White Rose passing this inspection. The general quality seems excellent although the amount entered for certification is greatly reduced as compared with 1948. Potatoes are recovering rapidly from the effects of the severe frost on the 29th of June. This recovery has become particularly pronounced since the first of August but the yields will be very low throughout this district unless a long unfavorable growing season occurs.—C. A. HENDERSON.

VERMONT

The total acreage of potatoes in Vermont is estimated by the Bureau of Agricultural Economics at 6400—an all time low since records were kept. There are, however, more large scale professional growers than ever before with fields between the 50 and 125-acre level. These growers are well equipped with up-to-date machinery and storehouses.

Stands in these commercial fields are good this year and there has been comparatively little virus or other disease. Late blight has been reported in only a few instances. The prolonged hot, dry weather has, however, unquestionably reduced yield. A small set has been reported in many cases, and tuber growth can scarcely catch up at present. Many fields as of the 1st of September were showing signs of ripening off.

About 660 acres were entered for certification and the percentage of rejection thus far is low. About 500 acres are evenly divided between Katahdins and Green Mountains, with Houmas making up most of the remainder.

Of the newer varieties a few fields of Tetons have apparently produced very satisfactorily.—HAROLD L. BAILEY.

DOMINION OF CANADA

The acreage entered for field inspection in 1949 amounted to 71,321 acres compared with 70,561 in 1948.

This is an increase of 760 acres above the final figures entered in 1948. However, there has been a decrease in all provinces except New Brunswick, Quebec, Saskatchewan and Alberta. The increase in New Brunswick amounted to approximately 3,000 acres, consisting mainly of Katahdins. There has been an increase in Katahdins, Chippewa and Sebago planted in Prince Edward Island with a corresponding decrease in Green Mountain and Irish Cobbler.

The leading varieties in Canada are Katahdin, Green Mountain, Irish Cobbler, Sebago, Netted Gem, Bliss Triumph, White Rose and Pontiac.

In general, the potato crop throughout Canada has suffered to some extent through lack of moisture, although it is a little early to determine whether any extensive damage has been done or not.

Seed Potato Certification Inspectors from coast to coast report that the crop is remarkably free from disease. Insects have done little damage where a systematic DDT spray or dust program has been used at frequent intervals.—J. W. SCANNELL.

Province of Prince Edward Island

The month of August was very dry until the 19th, at which time we had a downpour of rain which averaged three inches. Our crop is now doing very well. We have had a few traces of late blight but have kept it well in check this year.

Mr. S. G. Peppin, Chief of the Inspection Services, completed his final field inspection on the 3rd of September. He reports that there is a high percentage of Foundation and Foundation A seed in this year's crop. At the present time, indications are pointing toward fair to good yields and for the second year in succession no bacterial ring-rot has been reported. It is expected that our seed will be ready for shipment by the 15th of October.—E. D. Reid

THE POTATO ASSOCIATION OF AMERICA

An Historical Note

E. V. Hardenburg

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To be at all permanent, an organization should serve some useful purpose. In fact most societies originate from a need for some important functions to be performed. The Potato Association of America was organized more than 30 years ago and its record of useful accomplishment would seem to justify the ambitions of those who conceived it.

Certain phases of the potato industry began to assume national scope about the time of World War I when our food supply was a matter of concern. Federal grade standards were promulgated under the leadership of Herbert Hoover in 1917 when he was United States food administrator. The production of certified seed potatoes was begun in Wisconsin in 1914 followed by New York in 1915. Such matters as grade standards and the development of seed certification standards were of nationwide interest. There developed a need to provide a clearing house organization to coordinate such matters to the mutual advantage of all potato states. A publication in which the results of current potato research could be made available to all was needed. Varietal nomenclature was in need of clarification and the breeding of better varieties was demanded by growers. Out of this situation, came the Potato Association of America and its official publication.

Now that our organization has completed 25 years of publication, it is fitting that we here make note of the results. Beginning in November 1923, two numbers of Volume I were published that year under the

name, The Potato News Bulletin. Volumes II and III were published under the same title in 1924 and 1925, respectively. The name of the official publication was changed to American Potato Journal in 1926. Since then Volume 25, No. 12, December 1948 has been completed. Altogether 8910 pages have been printed in the 25 volumes. The writer had occasion recently to peruse an index of articles published in these first 25 volumes. Following is a classification of the 976 articles into subject matter headings.

Classification of Articles in First 25 Volumes of the American Potato Journal

Subject Matter	No. of Articles	Per cent of Total	Subject Matter	No. of Articles	Per cent of Total
Diseases and Insects	319	32.7	Costs	8	0.8
Seed	118	12.1	Plot Technique	7	0.7
Fertilizer	106	10.9	Weed Control	7	0.7
Internal Quality	59	6.1	Record Yields	6	0.6
Industry	56	5.7	Irrigation	6	0.6
Breeding	55	5.6	Vine Killing	5	0.5
Varieties	50	5.1	Sprout Inhibitors	4	0.4
Marketing	41	4.2	Wheel Injury	3	0.3
Anatomy and Botany	30	3.1	Harvesting	3	0.3
Storage	24	2.5	Grading	2	0.2
External Quality	14	1.4	Weather	2	0.2
Culture	14	1.4	Hollowheart	2	0.2
Planting	11	1.1	Machinery	1	0.1
Rotation	11	1.1	Livestock Feed	1	0.1
Soil	10	1.0	Sprout Tuber	1	0.1

Total number of articles written—976.

It is noteworthy that nearly one-third of the published articles concerned potato diseases and insects and their control. Other phases of the industry in order of their rank in published material were seed, fertilization, internal quality, industry problems, breeding and varieties. Rank in number of published articles may stand as an indication of the research interest and production problems characteristic of this quarter century of potato production in America.

Great credit is due Doctor William H. Martin and his coworker Dr. Elizabeth Clark for splendid work. Under the Editorship of Dr. Martin, the American Potato Journal has earned a place of respect among the scientific journals now published in America. This is to extend the thanks of the membership to him, to congratulate the Association on its good fortune and to present the hope that the next 25 years will be as satisfying.

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CRACKING OF TRIUMPH POTATOES[1]

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Nebraska Agricultural Experiment Station, Scottsbluff Substation, Mitchell, Nebr.

(Accepted for publication, May 6, 1949).

Introduction

Potato growers in western Nebraska are fully aware of the ease with which immature Triumph potatoes crack during harvest. Great care in handling these potatoes is necessary to avoid considerable tuber cracking. Records of certification inspectors show that an average of 15 to 25 per cent of potatoes harvested annually in western Nebraska are damaged by cracking to an extent that they fall below U. S. No .1 or even No. 2 grade. Actually, during most years cracking damage among individual growers ranges from 5 to 75 per cent of the tubers harvested. The nature and cause of tuber cracking in Triumph pota-

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[1]Published with the approval of the Director as paper No. 471, Journal Series, Nebraska Agricultural Experiment Station.

[2]Assistant Agronomist U.S.D.A., and Station Superintendent respectively. The authors acknowledge assistance of Dr. H. O. Werner, Horticulturist, Nebr. Agr. Exp. Sta., in the planning and general conduct of this experiment.

toes has been studied by Werner and Werner and Dutt (1, 2)[3]. These workers concluded that tubers crack at harvest primarily because of their high turgidity, and that they are most susceptible to cracking under conditions which tend to increase the water readily available to the tuber. An increase in soil moisture and a reduction in loss of water by transpiration which might be caused by frost, low temperature, or high humidity increases the water available to the tubers and makes them much more susceptible to cracking.

Extreme care in handling tubers during harvest has always proved advantageous in preventing or reducing the amount and severity of tuber cracking. However, under certain conditions the most careful methods of handling have not proved sufficient to prevent more or less serious cracking of tubers at harvest time. Werner and Dutt found that cutting roots a short time prior to harvesting Triumph potatoes was effective in reducing the amount of tuber cracking during harvest. Although many potato growers in western Nebraska have used the root cutting method successfully and to good advantage in reducing tuber cracking at harvest, many other growers, particularly in the irrigated section, have not adopted the method consistently. This may be due to a number of factors: (a) absence of a standard root cutting machine which will perform satisfactorily under varied conditions, (b) failure of grower to properly adjust and operate machines now available, (c) difficulties encountered in cutting potato roots where the crop has been grown after alfalfa which was plowed under as a green manure, and (d) difficulties encountered in digging potatoes on certain sandy soils after the root cutter has been used. Many growers have recently become interested in various methods of vine destruction in their efforts to do a better job of harvesting the delicate Triumph tubers. Vines have been destroyed with varied success by chemical sprays, land rollers and mowing machines. During the fall of 1948 considerable interest was aroused by the advent of the roto-beater. This machine chops the vines into small bits by means of paddles of hard rubber or iron attached to a large spool which operates at high speed. The great advantage of such complete destruction of vines for expediting the digging and hand picking of potatoes is self evident. However, in view of earlier research and experience which demonstrated that sudden destruction of vines failed to reduce cracking immediately, it appeared advisable to obtain further information about tuber cracking following the use of different methods of vine destruction as compared with root cutting.

[3]Figures in parenthesis refer to literature cited page 361.

Experimental Procedure

During the fall of 1948 an experiment was conducted at the Scotts Bluff Field Station to determine the influence of three preharvest treatments on the tendency of Triumph potatoes to crack during harvest. The three treatments comprised: (a) destruction of the vines by chemical spray, (b) destruction of vines by the roto-beater, and (c) severing potato roots with a root cutter. The chemical used for the vine spray treatment was a standard brand of the kind used in areas where this method of vine destruction is more common. The sprayed vines wilted within one day and died within four days. The three treatments, replicated twice, were applied on the 29th of September and again on the 3rd of October. Each plot consisted of two rows approximately 400 feet long.

The field of Triumph potatoes selected for this test showed a heavy growth of vines and little tendency for the plants to mature at the time the test was started. Soil moisture was adequate for good plant growth but not excessive. Samples of potatoes dug by hand between the hours of 8:00 and 10:00 A. M. were taken at random from each plot. Warm, clear weather prevailed until the 5th of October. Maximum daily temperatures varied between 62 and 80 degrees Fahrenheit and minimum temperatures between 42 and 50 degrees Fahrenheit. A killing frost occurred on the night of the 6th of October.

In order to determine how soon these treatments became effective or how long they remained effective, samples were dug by hand at two-day intervals until frost. Therefore, three samples were taken during the period from the 29th of September to the 5th of October. Fifty potatoes were dug from each treatment at each sampling date. Immediately after digging, each potato was dropped from a height of ten inches onto a cement brick. This uniform exposure to mechanical shock represented more severe treatment than potatoes encounter in ordinary harvest operations, but not necessarily more severe than some tubers encounter under careless methods of digging, picking and hauling. Immediately after this cracking test each sample was sacked separately and stored until it was graded at a later date. The samples were handled with extreme care in order to avoid further damage to the tubers. The potatoes were sorted into three grades—U. S. No. 1, U. S. No. 2, and culls—depending upon the amount and severity of cracking damage (other grade defects such as scab, knobs, etc. were ignored).

Results

The percentages of different grades of potatoes at various intervals after the preharvest treatments were applied are shown in table 1. The

percentage of the different grades of potatoes under the spray and roto-beater treatments was not greatly different than those from the check plot. The root cutter treatment showed considerable reduction in cull and No. 2 potatoes and an increase in No. 1 potatoes at each sampling date.

TABLE 1.—*Percentage of No. 1, No. 2 and cull potatoes at different sampling dates after vine destruction and root cutting. Potatoes graded on basis of cracks and bruises.*

Harvested		Treatment	Per Cent of Each Grade		
	Days after Treatment		No. 1	No. 2	Culls
October 1	2	No Treatment	23	44	33
		Spray	31	37	32
		Roto-beater	27	53	20
		Root cutter	67	28	5
October 3	4	No Treatment	27	48	25
		Spray	29	41	30
		Roto-beater	31	42	27
		Root cutter	62	32	6
October 5	6	No Treatment	35	46	19
		Spray	38	50	12
		Roto-beater	36	44	20
		Root cutter	54	42	4
October 5	2	No Treatment	35	46	19
		Spray	31	49	20
		Roto-beater	30	52	18
		Root cutter	58	32	10

The amount of U.S. No. 1 potatoes obtained in the check plot increased somewhat from the 29th of September to the 5th of October, probably indicating that the potatoes were naturally maturing to some extent during this period. On the 1st of October, 23 per cent of the tubers from the check plots remained in the No. 1 grade, compared with 27 per cent on the 3rd and 35 per cent on the 5th. The No. 1 potatoes from the spray treatment amounted to 31 per cent two days after treatment; 29 per cent, four days after treatment; and 38 per cent, six days after treatment. The amount of No. 1 potatoes from the roto-beater treatment amounted to 27 per cent, two days after treatment; 31 per cent, four days after treatment; and 36 per cent, six days after treatment. The greatest benefit from severing the roots of potatoes with the root cutter occurred within two days after this treatment was applied. At this date 67 per cent of the sample tubers, after being

dropped on a concrete brick, were still classed in the No. 1 grade, compared with 62 per cent four days after treatment, and 54 per cent six days after treatment.

The results of the application of treatments applied the 3rd of October and sampled two days later are somewhat different than results of application of treatments on the 29th of September. This may be due to the fact that much cooler and partly cloudy weather prevailed at this time. The results of sampling on the 5th of October from treatments made two days earlier show 35 per cent No. 1 potatoes in the check plot; 31 per cent, from the sprayed plots; 30 per cent, from the roto-beater plots; and 58 per cent, from the plots treated with the root cutter.

The potatoes from all plots were harvested according to common practice on the 9th of October. Samples of approximately 225 pounds from each plot were obtained and graded on the basis of mechanical injury. The results of preharvest practices on the grade of potatoes harvested according to common practice are shown in table 2. From treatments applied on the 29th of September and harvested according to common practice on the 9th of October, 61 per cent of the potatoes from the check plot were classed in the U.S. No. 1 grade compared with 67, 76, and 86 per cent from the spray, roto-beater, and root cutter treatments, respectively. From treatments applied the 3rd of October, 61 per cent of the tubers from the check plot were classed in the No. 1 grade compared with 62, 59, and 80 per cent from the spray, roto-beater, and root cutter treatments, respectively.

TABLE 2.—*Influence of preharvest practices on grade of Triumph potatoes commercially harvested on October 9. Potatoes graded on basis of cracks and bruises.*

Treatments	Per Cent of Each Grade		
	No. 1	No. 2	Culls
	Treatment Applied September 29		
No Treatment	61	27	12
Spray	67	22	11
Roto-beater	76	14	10
Root Cutter	86	10	4
	Treatment Applied October 3		
No Treatment	61	27	12
Spray	62	26	12
Roto-beater	59	27	14
Root Cutter	80	14	6

Summary and Discussion

An experiment was conducted at the Scotts Bluff Field Station during the fall of 1948 to determine the influence of preharvest treatments upon the tendency of Triumph potatoes to crack during harvest. The treatments used included: (a) destruction of vines by chemical spray, (b) destruction of vines mechanically with a roto-beater, and (c) severing potato roots with a root cutter. Each of these treatments was applied at two different dates—the 29th of September and the 3rd of October. The treatments were compared in each instance with a check plot which received no treatment.

The destruction of vines by chemical spray or mechanically with a roto-beater failed to reduce tuber cracking in Triumph potatoes during the eleven-day period of this test from the 29th of September to the 9th of October. The results indicated that during cool weather destruction of vines by either method might increase tuber cracking as compared with no treatment. Severing potato roots with a root cutter proved much more valuable in reducing tuber cracking than vine destruction with chemical spray or with the roto-beater. The greatest benefit from the use of the root cutter occurred within two days after the roots were cut. No benefits from the standpoint of the reduction of tuber cracking occurred even eleven days after vine destruction by chemical spray or mechanically with the roto-beater, whereas the root cutter treatment still showed considerable benefit after this period of time. From a practical standpoint, potato roots should be severed with a root cutter only a day or two ahead of digging.

Although the roto-beater failed to reduce the tendency of Triumph potatoes to crack during harvest in this test, it did facilitate greatly the actual digging and hand picking of potatoes. This appears to be the main advantage of vine destruction with a roto-beater. The use of the roto-beater for vine destruction early enough to allow for loss of turgidity and for ripening of the tubers before digging might not prove practical in western Nebraska because early destruction of vines could result in reduced yields; and on the other hand, late destruction of vines with an interval of time ahead of digging might place the tubers in serious danger of freezing. The elimination of vines at a late date might represent the removal of some protection from field frost. The destruction of vines directly ahead of digging might prove to be the most practical use for the roto-beater machine in western Nebraska. In view of the rather large and immediate benefits of severing roots with a root cutter in the reduction of tuber cracking, it is apparent that greater effort should be expended to perfect a root cutter machine

which will operate satisfactorily under all conditions encountered in digging potatoes in western Nebraska.

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RECENT FERTILIZER AND CULTURAL INVESTIGATIONS WITH THE POTATO*

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Most of the literature reviewed in this paper appeared in 1948. However, some publications of earlier years which have not been reviewed in this Journal are included.

GENERAL CULTURE

Houghland and Parker (21) in Virginia obtained the largest financial returns beyond estimated cost of seed and fertilizer from seed spaced 15 or 18 inches in rows 36 inches apart and from 2,000 pounds per acre of 5-10-5 fertilizer. Smith (55) presented a discussion of the following topics: improved potato varieties, methods of handling seed potatoes, fertilizing, chemical weed control, killing potato vines, harvesting machinery, insect and disease control, use of chemicals to retard sprout growth in storage and improved methods of marketing potatoes. Pratt (43) found that 15 of 17 blight resistant varieties yielded higher than Katahdin, Green Mountain or Rural. Ashworth and Essex yielded the highest weight of scabby tubers. The Essex, Chenango, Virgil, Snowdrift and Placid set the largest number of tubers. Chenango, Empire and Snowdrift were as good or better in appearance than Katahdin. Virgil, Placid, Fillmore and Essex had highest per cent of rough and unattractive tubers. Hardenburg (18) found that yields may be reduced from 10 to more than 50 per cent by vine injury caused by sprayer and tractor wheels. He found no relation of wheel injury to season of maturity or habit of growth of the varieties used.

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FERTILIZING POTATOES

Terman and Hawkins (60) state that considerably more P and K_2O fertilizer is commonly used in Aroostook County, Maine, for potatoes than is necessary for efficient production. Fertilizer applications range as high as 160 lbs. N, 320 lbs. P_2O_5, and 320 lbs. K_2O per acre. Tests show that 160 to 200 lbs. of P_2O_5 and K_2O are adequate on practically all the soils. A 2-3-3 ratio appears to be a more satisfactory ratio on most soils than any now mixed for the potato farmer. Applications of 120 lbs. N and 180 lbs. P_2O_5 and K_2O per acre are indicated. Peech (41) reported a marked accumulation of readily soluble P in all soils studied from the important potato-producing areas. This accumulation varied in different soils. In general, the amount of readily soluble P increased with the increasing degree of saturation of the soil with phosphate. In the light-textured soils containing large amounts of readily soluble P in the surface layer, there has been appreciable downward movement of P into the subsoil. Despite the low cation-exchange capacity and the low pH value, the exchangeable K content of many of these soils has been greatly increased by fertilization. This accumulation is relatively small as compared with the total amount of K applied over a period of years. The majority of the soils had pH values below 5. The amounts of exchangeable calcium and magnesium were very low. In some areas the soils were extremely deficient in magnesium. The organic matter content was low and was quite variable in many of the soils even within the same series. In some of the areas the organic matter content of the soils has been increased, whereas in other areas it has been decreased by cultivation.

The effect of manure and mineral fertilizers on the soil and on potatoes was investigated by Opitz (38). K was added as 40 per cent potash salts and P as superphosphate. Leuna saltpeter was the source of N. The effect of CaO additions was also investigated. N-P-K fertilization increased the soil pH from 4.2 to 5.2. The best soil reaction (pH 6.1) was obtained with N-P-Ca fertilization. The effect of manure depended only on its nutrient content; the organic material had no effect because of rapid decomposition. Complete fertilization increased potato yields about 3-fold. $NaNO_3$, $CaNH_4$ nitrate, $(NH_4)_2SO_4$ and $CaCN_2$ were compared as to their effect on the yields of potatoes. $CaCN_2$ was most beneficial. The addition of 30 kgs. per hectare of N was sufficient for potatoes. The average yield per kg. N was 80 kg. potatoes. Four K salts, kainite, 40 per cent potash salts, K_2SO_4, and KMg sulfate, were compared. The sulfates gave highest yields of potatoes. The Mg-containing sulfate often proved superior

to K_2SO_4, indicating a Mg deficiency in the soil. Lyons, Russel and Rhoades (30) obtained increased yields of potatoes when superphosphate was applied to calcareous soils. After a period of cropping where no manure or small quantities were used, superphosphate was also beneficial on non-calcareous soils. On calcareous soils it proved most beneficial when applied at 100 to 150 lbs. per acre; on noncalcareous soils, from 70 to 100 lbs. per acre. Comparatively few tests showed that western Nebraska soils were not deficient in K. Additions of Mg, Mn, Fe, Cu, Zn, or B were not necessary.

Analyses of virgin and cultivated Northern Wisconsin soils show that when potatoes are grown on these soils from 10 to 30 years the available phosphorus and soluble manganese content and acidity are increased whereas the available potassium, calcium and magnesium contents are seriously depleted, Berger (6).

Houghland (22) discussed the danger of considering gross rather than net returns from fertilizers.

Highest yields with respect to amount as well as to starch content were obtained by Schonfeld (47) on acid, unlimed soils; next were yields on lime-treated acid soils, and last on calcareous soils. Berger (6) found in Wisconsin that an application of 800 lbs. of 3-12-12 in the row increased the yield as compared with unfertilized by about 60 bushels per acre. More than this in the row was not beneficial but an additional broadcast application of 1200 lbs. 6-6-18 nevertheless gave a further increase of 80 bushels.

Nitrogen

Vlasova (64) found that physiologically alkaline forms of N consistently gave increased yields of potatoes over a period of 6 years. Physiologically acid sources of N consistently gave lower yields after the fourth and fifth years. The decrease in yield by the acid-giving salts may be partially overcome by liming. Tandon (59) found respiration rate of potato tubers, as measured by amount of CO_2 evolved per unit weight, increased with increasing fertilization during growth. The plots were given 0, 40, and 80 lbs. of N as $(NH_4)_2SO_4$ per acre, and the higher respiration rate of potatoes from the fertilized plots was observed whether determined at 64, 78, 92, or 103 days after planting. The extent of losses of potatoes during storage appeared to be correlated with the higher respiration rate.

Phosphorus

Van der Paauw (40) found that the yield and dry matter of potatoes increased with the amount of phosphate applied to a soil low

in phosphate. Six hundred kilograms P_2O_5 per hectare gave better growth than from any lesser quantity. Nitrogen was absorbed early under all concentrations of phosphorus, phosphorus absorption resulted only after a heavy P_2O_5 application. Nitrogen absorption stopped with the beginning of dying of the tops. The phosphate deficient plants remained green longer, possibly because their water output was less. The distribution of dry matter, water, nitrogen and P_2O_5 in the plants at various times was rather constant but marked changes occurred with the formation of tubers and the removal of dry matter from the leaves to the tubers which preceded the decay. The rate of total assimilation varied from 0.2 g. per gram leaf with abundant phosphorus fertilization to 0.13 in phosphorus-deficient plants.

A record is presented by Shcherba (48) of field experiments with different carriers of P, such as Thomas slag, ground rock phosphate, ordinary superphosphate, precipitated phosphate, and liquid phosphoric acid, on a series of crops. The raw rock phosphates and slags decreased the acidity of the soil. On the degraded (leached) chernozem, potatoes showed a preference for the soluble forms of P. No positive effect was noted from the gypsum of the acid phosphate on clover and potatoes.

Houghland (20) found that when the nutrient solution contained 1.5 ppm PO_4, the plants of Green Mountain variety made excellent growth, and in 0.5 ppm the plant height was slightly reduced and the dry matter and PO_4 in the plants were decidedly less. When the concentration of the solution was further reduced to 0.1 ppm, the plants were much smaller, symptoms of PO_4 deficiency developed, and there was a pronounced reduction in dry matter and PO_4. It is suggested that the 1.5 ppm concentration corresponds to the critical percentage of Macy, the 0.5 concentration his "poverty adjustment" and the 0.1 concentration his "minimum percentage." It appeared that mature leaves selected from the middle of potato plants could be used to determine the general level of PO_4 uptake. In general, the amount of PO_4 absorbed increased as the solution concentration increased, but the percentage of PO_4 recovered by the plants was greater in the more dilute solutions.

Jones and Green (23) obtained increased yields of potatoes from the addition of liquid phosphoric acid to the irrigation water.

Dean *et al* (12) found an inverse relationship between the phosphorus fertility status of soils and the percentage of phosphorus in the crop that was derived from the fertilizer applied at planting time. In pot tests with potatoes less than 2 per cent of the phosphorus in

the plants 20 days after emergence was derived from the fertilizer. At 80 days more than 50 per cent of the phosphorus in the plants grown on soil having a fertility level of 300 lbs. per acre of available P_2O_5 was derived from the fertilizer. On soil having a fertility level of 500 lbs. per acre P_2O_5, 30 to 50 per cent of the phosphorus in plants was derived from the fertilizer. There was a tendency for the plants grown on limed soils to have a higher percentage of phosphorus derived from the fertilizer than corresponding plants grown on unlimed soils. Contact placement as compared with band placement, tended to increase the per cent of phosphorus in plants which was derived from the fertilizer. The application to calcareous soil of 150 rather than 50 lbs. P_2O_5 in the form of superphosphate tended to increase the per cent of phosphorus in the rye grass derived from the fertilizer. Factors which affected growth did not necessarily alter the relative amounts of native and fertilizer phosphorus utilized by plants. Nelson *et al* (35) found that potatoes absorb a relatively high proportion of fertilizer phosphorus compared with native phosphorus throughout the growing period. The percentage of fertilizer phosphorus absorbed increased with the rate of application and decreased as the amount of native soil phosphorus increased. Potatoes absorbed approximately 10 per cent of the applied phosphorus on the soils highest in native soil phosphorus. Contact placement of fertilizer with the seedpieces decreased the percentage of phosphorus absorbed from the fertilizer.

Nelson and Hawkins (34) made a study to show the relationship between the amounts of readily soluble P and exchangeable K in the soil and the response of Irish potatoes to applications of these nutrients. Two years yield data from North Carolina showed that applied P gave significant increases in yield at all six test locations. Significant increases were obtained on 8 of the 9 experiments in Maine. The degree of yield response to applications of P_2O_5 was related to the amount of readily soluble P in the soil. Yield increases from the first 80 lbs. of P_2O_5 applied decreased as the amount of readily soluble P in the soil increased. The P content of the leaves in the North Carolina experiments was related to the amount of readily soluble P in the soil and to the amount of P applied. In the Maine experiments the P content of the rachises samples during the early-bud stage was related to the amount of P applied. P was particularly important in influencing the number of tubers per hill on soils low in readily soluble P. Significant increases in yield from applied K_2O were obtained in all experiments in North Carolina and in 5 out of 8 experiments in Maine. The weight of potatoes resulting from the first 60 lbs. of K_2O tended

to decrease as the amount of exchangeable K_2O in the soil increased. In the North Carolina experiments the K_2O content of the leaves was related to the amount of K_2O in the soil and to applied K_2O up to 120 lbs. of K_2O per acre. The amount of K extracted from the rachises of the potato plants in the Maine experiments was related to the exchangeable K_2O content of the soil and to the amount of K_2O applied.

Van der Paauw (39) found that the phosphate soluble in 1 per cent citric acid was satisfactorily correlated with the increase in yield obtained by fertilizing with phosphate. A P-citrate number of 40 represents a good phosphate supply for potatoes. The lime content of the soil influences the fertilizing effect of the phosphate; optimal results are obtained with 3-6 per cent lime. The clay content does not seem to change the fertilizing action. Superphosphate may possibly be somewhat more effective than dicalcium phosphate, but it injures the crop occasionally. No significant difference was seen if phosphate was applied before plowing in the fall or after plowing in spring. There was also a satisfactory correlation between the K-HCl number (K soluble in 0.1 N HCl) and the yield obtained by fertilizing with K salts if the clay and to a lesser extent the lime content of the soil was taken into consideration. A difference of 10 per cent corresponds to a difference of 2 to 4 units of the K-HCl number. Soils with about 3 per cent lime gave best effects.

Potassium

Brodskaya (10) showed that K_2SO_4 caused an increase of starch in the potato, compared with KCl. Sylvinite proved to be inferior to KCl for potatoes when physiologically acid salts of P and K have been used. With lime and organic matter, sylvinite proved to be superior to KCl. Fractional applications of K gave definite results if 25 per cent was applied when the soil was prepared, 50 per cent when plants came up, and 25 per cent at time of blooming. For potatoes the best form of K salts was K_2SO_4 in experiments on heavy soils for a period of 4 years (Pevzner, 42). Sylvinite and carnallite have proved to be inferior to KCl for potatoes. None of the salts increased the acidity of the soil or had any effect on the composition of exchangeable bases. When the levels of exchangeable soil potassium were above 220 lbs. per acre potatoes did not respond further to additions of potash to soils in Tennessee, Winters (69). Addition of sodium to the nutrient solution increased the dry weight of potato tops and roots when the potassium content of the solution varied from none to 210 ppm, Berger (6).

Influence of Calcium and Acidity

Wallace and Hewitt (66) grew sprouted potato sets, variety Majestic, in sand with and without calcium, both pots and sand being specially treated to ensure very accurate conditions of calcium deficiency where the element was omitted from nutrient solutions. Differential N treatments, *e. g,* nitrate, NH_3, and urea, were given and some cultures also received concentrations of Mn and Al sufficiently high to produce severe toxic effects. In the cultures from which Ca was omitted the plants failed completely and the shoots did not emerge above the level of the sand. The sprouts broke down immediately behind the growing points, after which they died off. The roots appeared fairly normal and the tubers remained firm. In all cultures to which Ca was added the shoots emerged normally and it was not until a later stage of growth that signs of the other unfavorable treatments were developed. It is indicated that the hard-tuber condition which occurs in failure of plants on acid soils results from the dying back of the young shoots prior to the emergence above the soil and that this is caused by a deficiency of Ca and is not due to the presence of Mn or Al. Goedwaagen and de Willigen (17) grew seven varieties of potatoes in soil of pH 4.55, 4.9, 5.5 and 6.3. The optimal pH for root development was lower than for optimal yield, the former varies from pH 4.5 to 5.5, the latter from 4.9 to 6.3. Berger (6) states that when soils are below pH 5.0 finely ground dolomitic limestone should be applied to add available calcium and magnesium to the soil and to reduce the amounts of soluble manganese present in some Wisconsin soils. Additional soluble magnesium in the fertilizer often is advisable.

Trace Elements

Brodskaya (9) found that on light podzolic soils the non-ballasted fertilizers, free of elements other than N, P, K in the fertilizer salts, proved to give higher yields of potatoes as well as higher yields of starch. Dostal (13) found that out of 12 minor elements in Hoagland A-Z solution, only B and Zn considerably increased the growth of the potato seedlings in solution cultures. Zn stimulated more the growth of the stems and B that of the roots and tubers. Mn and Cu, did not affect appreciably the growth of these seedlings. Katalymov (27) found an increase in boron uptake of potatoes along with an increase in yield, boron uptake varying from 53 to 106 grams per hectare.

Berger and Gerloff (7) described symptoms of stem streak necrosis which occurs commonly in potatoes grown on soils more acid than pH 5.0. Fertilizers which lowered the pH of the soil increased the

severity of the necrosis; it was prevented by the addition of lime. Neither acidity, soluble aluminum nor a deficiency of calcium, magnesium or boron was the cause of the necrosis. As little as 2 ppm soluble manganese in nutrient solutions caused severe necrosis identical to that observed in potatoes in the field. More than 2 ppm manganese was found in displaced soil solutions of soils on which stem streak necrosis had been prevalent in the field while only trace amounts were found in the solutions from the same soils after they had been limed in the field. The application of lime to maintain a soil reaction of pH 5.0 to 5.3 was the most practical means of preventing this necrosis.

Plant Tissue Testing

Nicholas (36) states that tissue test data when related to the seasonal cycle may be used to anticipate the development of mineral deficiencies and toxicities which may only become apparent later in the season. The method may be used to replace total chemical analysis for the rapid diagnosis of mineral disorders and may be used in a complementary role to other field methods. It has been found particularly useful as an adjunct to the visual method.

Atkinson *et al* (3) found that analysis of sodium acetate extracts of fresh potato stems showed that concentration of nitrates and potassium usually decreased as the season advanced. The concentration of phosphates tended to be at lower levels late in the growth period. The amounts of nitrates and potassium found in the plant tissues were usually increased when these nutrients were supplied in the fertilizer. The concentration of plant phosphates was not similarly affected by the addition of phosphorus to the soil. Frequently when the nitrate concentration was increased that of phosphate decreased and when the amount of nitrates showed a decrease that of phosphates showed an increase. Plants grown on the same fertilizer treatment on different areas could have approximately the same concentration of nitrates, phosphates and potassium in their tissues, but the yield from one area could be double that from the other.

Nyland (37) found that soil applications of nitrogen fertilizer at the rate of 80 or 160 pounds to the acre approximately doubled the nitrogen content of potato petioles and doubled the yields of tubers. The concentrations of soluble phosphorus and K_2O were inversely correlated with the soluble nitrogen content of the petioles. Applications of phosphate and potash fertilizers had no effect on yields of tubers nor on soluble nitrogen content of petioles. Maximum yields were obtained when the soluble nitrogen content of the petioles at time of first visible

flower buds was 600 to 700 ppm, the soluble phosphorus centent was 300 to 400 ppm. and the soluble K_2O was 4200 to 6200 ppm.

The application of fertilizers is reflected in the lower petioles of the plant by the methods of tissue analyses employed by Hill and Cannon (19). Tissue analyses indicated that if plants grown on muck soil contain less than 3,500 to 4,000 ppm. of potassium, yield will be depressed. From the lowest level of phosphorus up to 70 ppm. there was no relationship with yield but with levels above 70 ppm. there was a negative relationship. The negative relationship held only if the potassium level was below 3,000 ppm. With nitrogen up to 200 ppm. there is probably a positive relationship with yield, whereas with nitrogen from 200 to 1,000 ppm. there is a negative relationship with yield. There is a significant negative relationship between the combined nitrogen and phosphorus unit on potassium levels and the effects of the higher categories of nitrogen or phosphorus levels on yield are laregly conditioned by the potassium level.. A negative relationship exists between levels of potassium and magnesium and between potassium and calcium. Low potassium in the tissue is associated with an accumulation of magnesium and calcium.

Lignin as a Fertilizer

Potatoes grown in pots with layers of lignin between soil layers showed some increase in growth compared with soil alone, Dunn and Seiberlick (14). Aries (2) states that the use of lignin from dilute acid hydrolysis increased the starch content of potatoes by 85 per cent. A partially hydrolyzed wood containing cellulosic materials, as well as sawdust, gave less satisfactory results.

Application of Hormones

A study was made by Trnka, Frantek and Praskac (62) of the effect of the principal nutrients of commercial fertilizers when used with simultaneous hormonization with natural auxins in the liquid manure from pregnant cows and with synthetic heteroauxins of varying concentrations. The effectiveness of the nutritive substances was verified for potatoes. Their effect on the biochemical processes and the relative and absolute yield could not be duplicated by the substitution of other active principles of vegetable origin, especially the hormones. When used in connection with other biological elements and active principles, the liquid manure from pregnant cows did produce an increase in production. Synthetic heteroauxins in concentrations of 0.00125-0.005 per cent likewise produced an increase in absolute yield.

The hormonization of potatoes must be done before sprouting occurs, since otherwise the sprouts are burned. The increase in plant mass was due to the stimulating effect on the vegetable organs. The hormonization of potatoes still cannot be recommended as a universal means of increasing agricultural production. Malcher and Medal (32) state that treatment of potato tuber cuttings with heteroauxin increased the yield of Erstling 13.7 per cent, Ackersegen 22 per cent and Kurba 27 per cent. Hormone treatment increased nitrogen, starch and ash content of tubers. Other experiments were made with 8 tablets of Euradin in 200 liters of water applied to 25 kilograms of seed potatoes and with Euradin plus alpha naphthyloctylacetic acid.

Weed Control with Chemicals

Bradley and Ellis (8) reported that applications of 0.875 lb. per acre of 2,4-D in the form of 70 per cent sodium salt in the regular potato spray mixture resulted in control of weeds and no significant decrease in yields of Katahdin. Warren and Hernandez (67) found that 2,4-D mixed in the soil or sprayed on the soil surface at rates of 2 and 4 pounds to the acre resulted in fair control of weeds and no significant reduction in yield of potatoes on muck soil as compared with plots where weeds were allowed to grow. A direct spray of 0.8 pound 2,4-D when potatoes were about 8 inches high resulted in good weed control. Alban and Keirns (1) found that repeated applications of 0.13 and 0.33 lb. butyl ester of 2,4-D reduced the number and size of weeds in Katahdin potatoes but serious injury was caused to the crop. Potatoes grew satisfactorily when 1.32 lbs. butyl ester of 2,4-D was applied as a pre-emergence treatment. Thompson and Shuel (61) obtained excellent control of annual broadleaved weeds in potatoes from 2,4-D applications at the rate of 1.2 lbs. to the acre. Neither yield nor quality of Katahdin potatoes was depressed in 1946 or 1947. A varietal and seasonal difference in reaction to 2,4-D was found, Cobbler being more sensitive than Katahdin.

Smith, Meadows and Marshall (56) presented results of three year's research on controlling weeds in potatoes with chemicals. The best control of weeds was obtained by application of materials from two to three weeks after planting but before potatoes emerge. Post-emergence application of 2,4-D at time of last hilling at the rate of one pound to the acre controlled weeds and resulted in no injury to the potatoes. Excellent weed control and high yields of potatoes were obtained from applications of Dow Contact Weedkiller, Sinox General plus diesel oil, pentachlorophenol and oil, sodium pentachlorophenate,

Esso HAN 132 and several other oils. Excellent control of weeds but some decrease in yield was obtained from sodium and ammonium trichloroacetate. 2,4-D resulted in decreases in yield in some areas in 1948.

Smith, Marshall and Meadows (57) found that potato growing methods could be changed considerably from the conventional methods when weeds are controlled with chemicals instead of by cultivation. By planting potatoes in rows closely spaced and by very high applications of fertilizer and a high rainfall yields approaching 1,000 bushels to the acre were obtained. The method appears to be especially suited to the production of potatoes for seed purposes.

Killing Potato Vines

Callbeck (11) found that tubers from untreated cut vines showed a greater incidence of stem end discoloration than tubers from untreated plants or from plants destroyed by slow acting herbicides. Tuber vascular discoloration appears to be correlated with rapidity of kill of the tops. The amount and intensity of discoloration of tubers from plants killed at different stages of development with dinitro compounds increased quite regularly with the age of the plants. There were no differences in culinary quality of cooked tubers from the various treatments. McGoldrick and Smith (33) found that those killing agents which destroyed top growth most efficiently and rapidly reduced specific gravity of the tubers compared to lesser destruction and those unkilled. Discoloration of the vascular region of tubers was decidedly increased by killing injury to top growth. Neither killing agents nor application dates appeared to have a significant effect on the value of tubers as a source of seed the following season. Kunkel, Edmundson and Binkley (28) found that killing vines resulted in lower specific gravity of the tubers and that tuber color with Bliss Triumph and Red McClure faded with maturity. Dowspray 66 and Sinox are considered worthy in Colorado. No significant increase in stem-end discoloration resulted from their use in 1947.

Retardation of Sprout Growth

Smith (49, 50) and Smith, Ellison, Van Geluwe and Baeza (51) have described the methods of application of methyl ester of naphthaleneacetic acid to potatoes for retardation of sprout growth in storage. Application in dust form resulted in excellent control of sprout growth and usually is more convenient to apply than the liquid in spray form. Smith and Scudder (54) described the methods of applying methyl ester of naphthalenacetic acid in the liquid and dust forms to potatoes

in storage. In some instances decay in storage was increased by application of this material on Long Island in 1946, especially to potatoes which were immature and badly bruised at time of storage.

Smith, Baeza and Ellison (53) found potatoes resistant to spray applications of 10 ppm. 2,4-D and 10,000 ppm. methyl ester naphthaleneacetic acid when applied in August to the foliage. Injury resembling common scab occurred on many tubers from plants which had been sprayed with the latter material. Tubers from plants which had been sprayed in the field with methyl ester of naphthaleneacetic acid had less sprout growth after three months storage at 50°F. than from untreated plants. Ellison and Smith (15) obtained reductions in yield and specific gravity of tubers when plants were sprayed in July with methyl ester of naphthaleneacetic acid but no reductions from August and September applications. Sprouting of tubers in storage was best controlled by the July application but application in August also significantly reduced sprout growth. The September application had no effect. Reducing sugar content of treated tubers was lower than of untreated tubers. No significant differences were found between yields of treated and untreated tubers.

Smith, Ellison and McGoldrick (58) found that spray applications of 2, 4, 5 trichlorophenoxyacetic acid to potato plants in the field retarded subsequent sprout growth in storage. The same chemical applied to tubers in storage retarded sprout growth as efficiently as methyl ester of naphthaleneacetic acid when penetration in the tubers was assured.

Chemical Composition

Studies were made *in vivo* by Rubin and Sokolova (46) on the influence of different temperatures on the hydrolytic and synthetic activities of sucrase as well as the intensity of starch synthesis without differentiating the action of various enzymes. The optimum temperature for starch formation in the leaves varies with the age of the plant. In late July and early August it is 30°; in late August it is 40-50°. The synthesis of starch and sucrose in the leaves is not stopped even at 50° at the end of the growing season. Tests on potato tubers in September and December showed that sucrase maintained a high thermal optimum but that the optimum for starch synthesis was 37° in September and synthesis stopped at 45°. In December it stopped at 40°. The same diurnal rhythm in the carbohydrate metabolism of potato plants was observed by Kasparova and Vartanetyan (26) in the Arctic regions as in the temperate zones. The maximum activity of hydrolytic enzymes during the intense formation of the vegetative

organs was at the early morning and evening hours. Potato varieties suitable for Arctic planting are characterized by a high level of oxidative processes in the autumn period.

Prokoshev and Saval'eva (45) found that the citric acid content of potato leaves, dry weight, was 0.882-1.280, stems 0.165-0.149 and tubers 0.812-0.966 per cent. The highest concentration occurs at the top and in the center with progressive lowering in the bottom part and the cortex. No relation was found between the starch and citric acid content in the tubers. Air storage of cut stem or tuber samples for 2 to 3 days lowers the citric acid content by 12 to 25 per cent showing its utilization in respiration.

Vitamin C in Potatoes

Josefsson (24) for analysis of vitamin C used only boiled potatoes. The highest vitamin C content was obtained in unpeeled potatoes put in cold water, boiled, mashed, then mixed with 2 per cent HOP_3 to avoid further oxidation of the ascorbic acid. Small tubers were markedly superior to the large ones in vitamin C content, especially during the growing period, but the differences rapidly diminished during storage. In 1941 and 1942 the changes in vitamin C were followed during the latter part of the growing period. In these experiments the production of vitamin C seemed to be correlated with differences in temperature and light. The importance of sunshine and warmth was strongly borne out. During storage the decrease of vitamin C content was more pronounced both absolutely and relatively in varieties with high vitamin C content. Werner (68) analyzed Nebraska potatoes for their ascorbic acid content, and results showed that some varieties were superior to others. Potatoes from green vines were superior to those from mature or dead plants; and straw-mulched or dryland potatoes had higher values than nonmulched or irrigated potatoes. The amount of ascorbic acid in all potatoes decreased rapidly during storage but more rapidly at low than at high storage temperatures.

Baird and Howatt (4) studied the effect of fertilizers, vine killers, maturity and length of storage on the ascorbic acid content of nine varieties of potatoes. Ascorbic acid content was not affected by variety, fertilizers or vine killers. The apical ends of the tubers contained 20 per cent more ascorbic acid than the basal end. The highest values of ascorbic acid were obtained in August. Losses during maturation and storage were continuous and regular.

Reciprocal grafts were made by Kelly and Somers (25) between potato varieties having tubers with different ascorbic acid contents.

In addition potato rootstocks were grafted with tomato scions. Although differences in weight of tops and tubers and ascorbic acid content of leaflets resulted, the ascorbic acid content of the tubers was not affected by the nature of the scion. The ascorbic acid content of tubers was regulated by the genetic constitution of the underground portion of potato plants regardless of the genetic constitution of the aerial portion.

Vitamin C analyses are given by Baker, Parkinson and Knight (5) for 13 varieties at harvest and after storage of 5 to 6 months. These can be grouped as high, average and low in vitamin content. Values for stored potatoes are very low. One variety retained vitamin content very well in storage. No influence of various fertilizer treatments upon the vitamin content was detected in the varieties tested. Wokes and Nunn (70) found that the loss of vitamin C during winter storage was related to atmospheric moisture and the tendency to form sprouts. Changes in storage temperature between 3 and 31° was not a factor.

Prokoshev and Petrochenko (44) showed that the formation of ascorbic acid in the tissue of potato as a result of a wound is determined by an increase of cell requirements of this substance, which is related to the changes in the structure of plasmatic proteins. The changes of protein metabolism are primary and the ascorbic acid requirement is derived from them. The most important protein change is an increase of the denatured state. Infiltration of 0.02-0.2M ascorbic acid into sections of potato showed strong adsorption and almost complete cessation of biosynthesis of ascorbic acid if its infiltrated level reaches 30-43 mgs. per cent.

Potato Quality

Smith (52) showed that every lot of potatoes has a wide range in specific gravity and that specific gravity determines the degree of mealiness of potatoes. Specific gravity is directly related to dry matter content of the tubers. There are large differences between varieties in both specific gravity and mealiness. The same lot of potatoes can be separated into lots which are especially suited to boiling, frying and baking. Turnquist (63) determined the firmness of flesh of potato tubers by a pressure tester and compared the results with dry matter and specific gravity of the tubers. Differences in firmness of flesh were obtained between varieties and locations where they were grown. The association between pressure test readings and specific gravity was significant only in the case of the total correlation. Some factor in addition to dry matter influences firmness of flesh as measured by the

pressure tester. Linn, Apple and Arnold (29) obtained increases in specific gravity of tubers of ten out of eleven varieties by applications of DDT.

Stem end blackening of potatoes has been found by Wager (65) to be caused by a combination of a pigment precursor with iron. The addition of small amounts of iron salts to potato extracts greatly increased its color intensity.

Wolfenbarger, Decker and Rawlins (71) found a positive relationship between amount of benzene hexachloride applied to the soil and an increase in the number of tasters reporting off flavor in cooked potatoes which had been grown in these soils.

Machacek (31) found in a survey of Manitoba grown table stock potatoes that about 50 per cent of the samples collected consisted of mixed varieties. In 45.9 per cent of the samples the average weight of the tubers was below the optimum desired by urban consumers in certain Atlantic Coast cities. Waste from paring alone averaged 20 per cent by weight but ranged from 13.5 to 26.2 per cent. Waste from rotting, internal discoloration and related defects averaged 7.7 per cent but varied from a trace to almost 40 per cent. The monetary loss to consumers ranged from 1.6 to 103.2 cents per 100 lbs. purchased. Eskew (16) described the methods used in Europe for the utilization of potato starch factory wastes.

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DISINFECTION OF A NEW STATIONARY-TYPE SEED-POTATO CUTTER TO CONTROL THE SPREAD OF RING ROT[1]

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Introduction

The double-edged stationary potato cutting knife (4) was introduced to provide growers of small acreages of commercial potatoes with an inexpensive seed-potato cutter which could be automatically disinfected for ring-rot control. It has been found, however, that the tip of the blade has a tendency to vibrate during rapid cutting. This paper describes an improved model of the stationary knife which overcomes this tendency of the original model.

Description of the Tension Blade

This potato cutter consists of a hack saw (or a length of band saw blade) which has been ground sharp on both edges and mounted vertically in a rigid frame. The disinfecting solution is supplied by a means of a rubber tube leading from a tank to a wick fitted around the upper end of the blade.

Figure 1 shows the arrangement of the blade, frame and disinfectant supply. Each end of the hack saw blade (SB) is fastened by pins into slots in the end of a 1/2 inch square steel rod (R). These slots should fit the blade snugly to eliminate twisting of the blade. The upper square rod passes through a closely fitted square hole in the guide bar (GB) and then through the top member of the frame. A nut threaded on the upper end of the rod permits the assembly to be tightened to hold the blade rigid.

A piece of lamp wick is fitted around the upper end of the blade in such a way as to form a small cloth cup (Lw), which fits the blade closely below but flares slightly above. The disinfectant is introduced into

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this cup by way of a rubber tube (RT) from a tank above. Regulation of the rate of flow of the disinfectant may be by a valve at the base of the tank or by a screw-type pinch clamp applied to the rubber tube. It may be desirable to solder a metal cup (C) around the rod to which the base of the blade is attached to receive the waste disinfectant. It can thence be conveyed to a waste tank. The disinfectant should not be re-used.

Figure 2 illustrates the arrangement of the blade and frame in relation to a supply of seed tubers so that the operator may work with a minimum of lost motion (4).

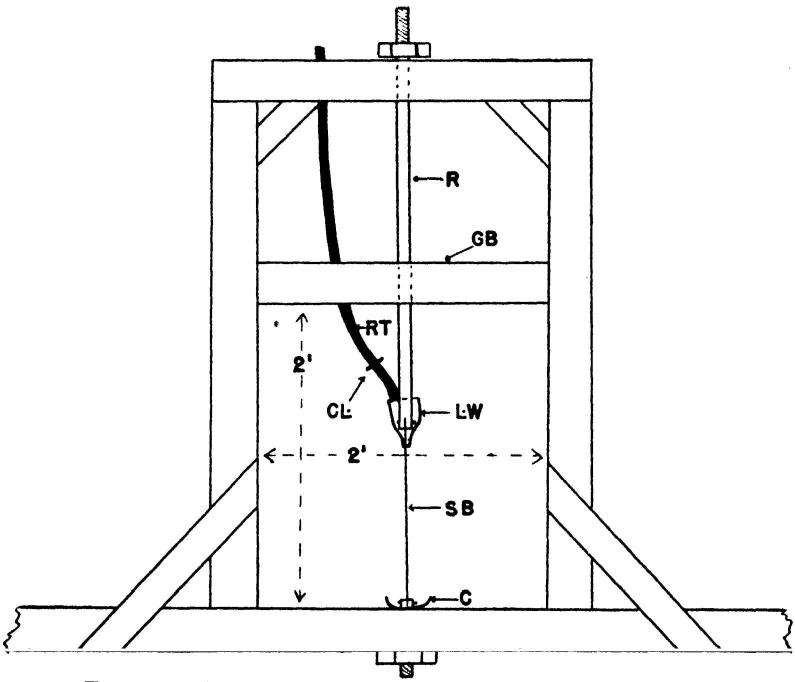

FIGURE 1.—DIAGRAM OF THE TENSION BLADE IN FACE VIEW.

Care must be exercised at all times to make sure that the disinfectant is flowing uniformly over both sides of the blade to insure satisfactory ring-rot control.

MATERIALS AND METHODS

In tests previously reported (1, 3, 4) it was observed that disinfection of the stationary double-edged knife tended to be less efficient when the cutting motion was continuously in the same direction as was necessary for rapid operation on tuber lots of 2-seed piece size. The addition

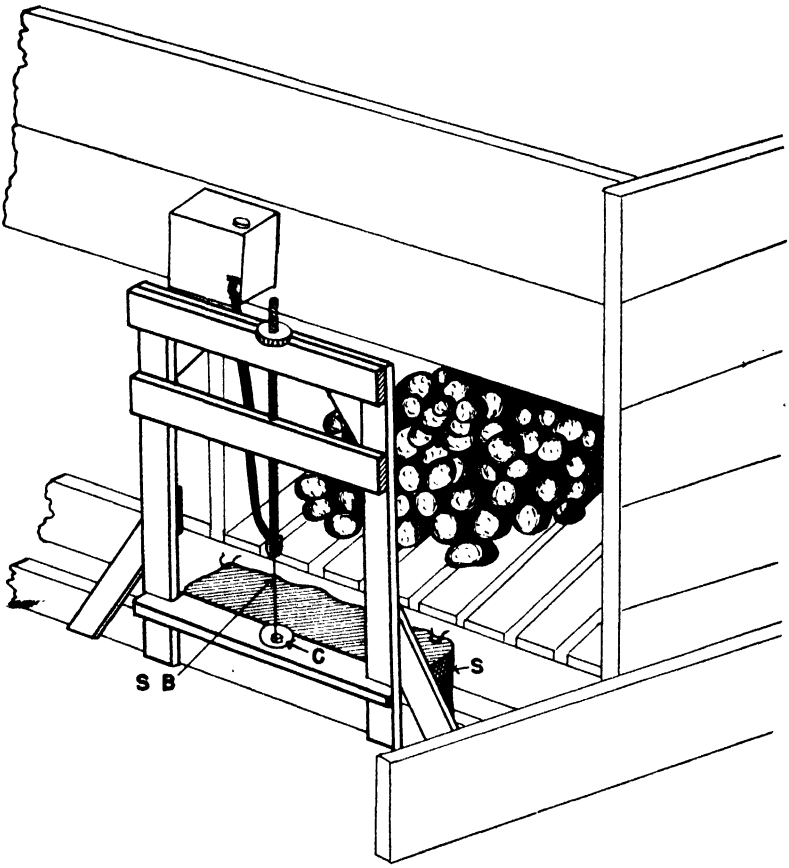

FIGURE 2.—ARRANGEMENT OF THE CUTTER AND SEED POTATO SUPPLY FOR SPEED AND CONVENIENCE OF OPERATION

of a wetting agent to the disinfectant solution was found to increase the effectiveness of ring-rot control. It might have been assumed the disinfection techniques used on the stationary double-edged knife would prove successful on the tension blade, but it seemed advisable to test this assumption in the field. Tests paralleling those made on the original double-edged knife, testing the effect of 1-way and 2-way cutting and the addition of a wetting agent to the solution, were conducted in 1947 and 1948.

In 1947 a supply of foundation Irish Cobbler seed potatoes was randomly distributed into 5 lots of approximately 55 tubers each. Fifteen to 16 tubers of each lot were then assigned at random to a control lot to be planted without cutting as a check of tuber-borne infection.

The remaining tubers of each lot were used for the cutting treatments. These were cut with the tension blade after contaminating the blade by smearing it with a ring-rot infected tuber. The blade was recontaminated after each tenth tuber cut.

Two solutions were tested for disinfection of the blade. One was 0.2 per cent mercuric chloride solution, the other was the same solution plus the wetting agent, Triton X300. The solutions were used at the rate of 2 quarts per hour. One lot of tubers was cut without disinfection to determine the effectiveness of the inoculation. Two lots of tubers were cut while using each of these disinfectant solutions on the blade. In one lot the cutting motion was always in the same direction, in the other alternate tubers passed the blade in opposite directions.

The whole tubers and cut seed pieces of each lot were then planted in 3 randomized blocks, 26 hills per plot. The tubers were cut on the 23rd of May and planted at Fort Collins, Colorado, on the 5th of June, 1947.

In 1948 a supply of foundation Red McClure seed potatoes was divided as described above to make 6 lots, one to be planted without cutting and 5 for cutting tests. Two chemicals were used as blade disinfectants, 0.2 per cent mercuric chloride and calcium hypochlorite solution containing 5000 ppm of chlorine. Contamination of the blade was as described above. One lot was cut without disinfection as in the previous year. Two lots were cut while using each chemical as the blade disinfectant, one before and one after the addition of Triton X300 to the solution. Disinfectants were used at the rate of 2 quarts per hour. Uni-directional cutting, being a more severe test of disinfection (1), was used on all lots of tubers.

Two plantings of the seed pieces were made—one of the 3 randomized blocks, 14 hills per plot, and the other of 5 randomized blocks with 22 hills per plot. The tubers were cut on the 23rd of April and planted the 1st of May, 1948, at Fort Collins, Colorado.

In each year the number of plants and the number of ring-rot infected plants per plot were determined in September. Determination of ring-rot infection was based primarily on vine symptoms. The stem-ooze test (2) and examination of tubers in the hill were resorted to in doubtful cases.

Results and Discussion

Table 1 presents the results of the two years' tests. No statistical differences were discovered in the stands. The incidence of ring-rot in the disinfected and in the whole tuber lots was so low, in contrast to

the non-disinfected lot, that no statistical treatment was necessary. It is obvious that satisfactory control of the spread of the ring-rot organism by the cutting knife was accomplished.

TABLE I.—*Stand and number of ring-rot infected potato plants. 1947 and 1948 tests of the disinfection of the tension blade.*

		1947		1948	
Knife Disinfectant	Direction of Cut[1]	Total No. of Plants	Total No. of Ring-rot Infected Plants	Total No. of Plants	Total No. of Ring-rot Infected Plants
Uncut tubers	—	75	0	133	0
None	1-way	71	35	140	79
0.2 per cent $HgCl_2$	1-way	73	0	143	1
0.2 per cent $HgCl_2$	2-way	68	1	—	—
0.2 per cent $HgCl_2$ +Triton X300[2]	1-way	76	0	139	1
0.2 per cent $HgCl_2$ +Triton X300	2-way	69	1	—	—
5000 ppm Cl[3]	1-way	—	—	141	0
5000 ppm Cl +Triton X300	1-way	—	—	137	0

[1]1-way. All tubers pass the blade in the same direction; 2-way, alternate tubers pass the blade in opposite directions.
[2]Sodium salt of alkylated aryl polyether sulfate, 1/2 ml. per gallon.
[3]Tested with the Taylor Chlorine Slide Colorimeter.

It may be noted, however, that there appear to be no differences in the effectiveness of disinfection due to 1-way or 2-way cutting or to the presence or absence of the wetting agent in the disinfecting solution. Possibly the narrower, thinner, flatter blade of this cutter and its inherent greater stability may promote a more uniform spread of the disinfectant on the surface of the blade than is obtained on the broader. more flexible blade of the stationary double-edged knife (4). This may account for the differences in results obtained with the two cutters.

Calcium hypochlorite solution containing 5000 ppm of chlorine gave us good control of ring-rot transmission as 0.2 per cent mercuric chloride. The hypochlorite solution may be preferred by some growers, despite its odor, because of the poisonous nature of mercuric chloride.

SUMMARY

The tension blade, an improved type of the stationary double-edged potato cutting knife, is described.

Field tests of the disinfection of this cutter have shown satisfactory control of the spread of the ring-rot organism.

No significant differences in control were found between (a) 0.2 per cent mercuric chloride solution and calcium hypochlorite solution containing 5000 ppm of chloride used at the rate of 2 quarts per hour; (b) 1-way and 2-way cutting; and (c) the presence or absence of wetting agent in the disinfecting solution.

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SECTIONAL NOTES

Maine

Farmers are, in general, on the last half of their digging. Many started digging on the 19th of September but, because of frequent rains, harvested only one day that week. Digging is slow as a result of the big yields which farmers are getting. Many are averaging 200 barrels per acre with some individual fields averaging much higher. Excellent seed planted close, large applications of fertilizer, (2,000 lbs. of 8-12-16 or equivalent) a good spray program, and enough moisture are giving the largest yield in history.

A frost on the 17th of September and another heavy frost on the 30th killed the tops so that top-killing was necessary only on stock dug before the 17th. The Rotobeater has been used on some fields that were killed by frost. It makes easier and cleaner picking.

What is considered a picking record for women was established this fall when one girl picked 155 barrels of potatoes in one day.

A few certified fields are being rejected for ring rot. On the whole, however, less ring rot is being found in Certified Seed than ever. Table stock is also showing less ring rot than previous years.

Dr. Bonde's and Dr. Schultz's recent Bulletin No. 471 entitled "Control of late-blight tuber rot" was mailed to all potato growers of Aroostook, but in spite of the warning in the Bulletin some potatoes were harvested when tops were partially green as the first frost did not

thoroughly kill all fields. Some of the potatoes are showing late-blight rot. This condition is not general, but some growers are finding breakdown when these potatoes are being shipped.—VERNE C. BEVERLY.

NEBRASKA

Harvesting of the main crop in the western high plains areas of Nebraska started during the week of the 19th of September. This is somewhat earlier than the main harvest is usually begun, and was due to an unusually early frost on the night of the 12th. This frost, however, did not strike all the western area, and some fields were still partially green on the first of October.

At this time, harvest is about one-half completed, and barring weather difficulties, should be finished by the 10th of October. The general quality under both dry and irrigated conditions is better than it has been for two years. Scab, which has plagued growers and shippers alike seems to be substantially less, except in areas afflicted every season. Because of greater maturity, the tubers are being harvested with much less mechanical injury than usual. This difficulty with the Triumph variety is a common complaint, and any improvement is welcome. Because of this difficulty, many growers have been shifting to other varieties, principally Pontiac and Progress, the latter a newly named variety released to the general public a year ago.

Lighter yields were experienced over most of the territory because of the frost, and a fairly general blight epidemic, which matured many fields about the middle of September.

The yields on the dry land areas vary from 125 to 175 bushels, whereas irrigated yields range from 300 to 500 bushels per acre. Too few sales have been made to establish a market, although field run potatoes are being sold and are going into storage at prices ranging from \$1.25 to \$1.50 per cwt. This is without sacks or grading. At the present time, the market for graded potatoes is lower than this, considering grading and sacking costs.—MARX KOEHNKE.

NEW YORK

New York farmers are delayed in harvesting their potatoes because of wet weather and the fact that Fall rains have prolonged the growing of the vines. The crop will average about the same as last year on an acreage basis but there will be a bigger shrinkage because of over-size deformed tubers, etc. The crop has doubled during the last three weeks.

Certification is now completed and shows about 1 per cent decrease in acreage compared with last year. The volume will be further cut by

oversized tubers in some cases and because many growers will not sort out the large size potatoes but market the whole crop as table stock.

Many favorable comments have been received on the yield and quality of new varieties like Essex, Ashworth and Ontario. Some of these varieties will make a good name for themselves in the potato picture.

Marketing agreement meetings are in the offing for this fall and winter. Growers, however, are not favorable to the compulsory and regimental features of potato legislation now in the air and their attitude is changing away from a Marketing Agreement that is not voluntary.

Markets are, at the present time, oversupplied with local potatoes of varying quality but it is anticipated that the coming of cold weather will be good for the industry as a whole in this respect.—H. J. EVANS.

NEW YORK

Field inspection was completed by the middle of September. Most of our growers are now in the process of harvesting. Preliminary lists of the acreages passed have been sent to growers and county agents. The more important varieties grown in order of importance, based on acreage, are: Katahdin, Sebago, Ontario, Essex, Chippewa, Green Mountain, and Irish Cobbler.—J. JOHN MACABEE.

NORTH DAKOTA

North Dakota Certified Seed Potato Growers have enjoyed very fine Fall harvesting weather. The crop was practically harvested by the 5th of October and is in very fine storages. The quailty of the crop was unusually good and should result in shipment of excellent certified packs. The certified acreage was 22,000 this year compared with 29,000 last year. The largest reduction was in the Cobbler variety and there were definite increases in the certified Pontiacs and Red Pontiacs. Many cars have already moved to Cuba and South Florida. Shipments will be made to this action early in October.—R. C. HASTINGS, *State Seed Commissioner.*

OREGON

The Second Field inspection of certified potatoes has just been completed. The results aren't yet available but the percentage meeting requirements seems to be slightly above normal.

Our potato growing season came to an abrupt end with a heavy frost on the 16th of September. The yield this year will be considerably below normal because of the late spring frosts. However, recovery

has been good but not sufficient to make more than about 70 per cent of a normal crop. The use of good seed was responsible for much of the recovery.—C. A. Henderson.

HIGH PLAINS POTATO CONFERENCE

SEPTEMBER 9-10, 1949

The Annual Meeting of the High Plains Potato Conference convened to the Alliance Hotel, in Alliance, Nebraska, the morning of the 9th of September, with 45 persons in attendance. Persons from five states were in attendance, the largest number being from Wyoming, Colorado and Nebraska. The two days were devoted to discussions on current problems in the industry and were mostly of the round table discussion type.

The problems of introducing new varieties to the trade were discussed from the standpoint of both the breeder and other interested agencies. This discussion was led by H. O. Werner. Discussions of problems involved in producing Foundation Seed Stocks were led by M. W. Felton. New certification problems were outlined by Marx Koehnke, who led a discussion of this general subject. G. H. Starr conducted the discussion on new disease problems. Roscoe C. Hill led off on insect pests and general control.

A field trip to visit the general rotations in breeding work took place at the Box Butte Experiment Station and the Scotts Bluff Experiment Station.—Marx Koehnke.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of American Potato Journal, published monthly at New Brunswick, New Jersey, for October 20, 1949.

State of New Jersey ss
County of Middlesex

Before me, a Notary Public in and for the state and county aforesaid, personally appear W. H. Martin, who having been duly sworn according to the law, deposes and says that he is the Editor of the American Potato Journal and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411. Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers, are:

Publisher—Potato Association of America, New Brunswick, New Jersey.
Editor—W. H. Martin, New Brunswick, New Jersey.
Business Manager—John C. Campbell, New Brunswick, New Jersey.

2. That the owner is: (if owned by a corporation its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given).

Potato Association of America, New Brunswick, New Jersey.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state). None

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholders or security holders appear upon the books of the company as a trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stocks and securities, in a capacity other than that of a *bona fide* owner and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is—(This information is required from daily publications only).

JOHN C. CAMPBELL, Business Manager.

Sworn to and subscribed before me this 10th day of October, 1949.
Anna C. Bergen, Notary Public, Middlesex County, New Jersey.
(My Commission Expires March 7, 1954).

Form 3526—Ed. 1924.

ANNOUNCEMENT

The committee which was appointed at the Pittsburgh Annual Meeting to explore the possibilities for visual education aids is requesting the membership to bring to or send to the Chairman, prior to the Kansas City meeting, their suggestions, samples and ideas for visual education material. We are requesting individuals to bring only a half dozen or so of their best photographs (slides and prints) dealing with potato insects, diseases or other subjects of interest in potato production. An opportunity for exchanging extra photographs will be provided. Samples of plastic-embedded specimens and movie films or any other usable visual education material are also solicited. It is hoped that as a result of this meeting the Committee will be able to set up a system of distribution of the material to the membership and interested persons.

COMMITTEE FOR VISUAL EDUCATION

Gordon A. Brandes, Rohm & Haas Company,
222 West Washington Square, Phila., Pa.

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OLD AND NEW POTATO VARIETIES

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(Accepted for publication September 29, 1949)

The number of potato varieties being grown in the United States is increasing year after year. According to a summary of certified seed potato production prepared by the Bureau of Agricultural Economics, United States Department of Agriculture, 51 varieties are found in the certified lists for 1948. Twenty of these are old varieties that were produced during the last half of the nineteenth century. The other 31 are comparatively new, since they were distributed to growers during the last 17 years as will be noted from tables 1 and 2. The old varieties make up approximately 56 per cent of the total certified seed and the new 44 per cent.

Thirteen varieties (7 old and 6 new) constitute about 96 per cent of the total. They rank as follows: Katahdin, 27.56 per cent; Irish Cobbler, 15.47; Triumph, 13.31; White Rose, 8.79; Russet Burbank, 7.14; Chippewa, 7.10; Green Mountain, 6.85; Sebago, 3.12; Red Mc-

[1]Principal Geneticist.

Clure, 2.12; Pontiac, 1.93; Red Warba, 1.02; Dakota Chief, 1.02; and Russet Rural, 1.01.

Twenty-seven of the new varieties were produced by crossing and selection. The other four were the result of bud mutations or sports. In every case these were color mutations: The Red Warba from Warba; the Dakota Chief and White Pontiac from Pontiac; and the Russet Sebago from Sebago. The Red Warba is a red-skin variety, in contrast to the Warba, which has a white skin and pink eyes. The Dakota Chief, sometimes called the Red Pontiac, is supposed to have a deeper red skin color than the original Pontiac, whereas the White Pontiac resulted from the loss of the red color of the parent variety. The Russet Sebago, as the name implies, has a russet skin, in contrast to the smooth white skin of the original Sebago. No other changes are claimed for the new selections except for Russet Sebago which may be somewhat more scab-resistant than the white-skin Sebago.

TABLE 1.—*Old varieties on the certified seed-potato list in* 1948.

Variety	Specific Gravity (Maine, 1948)	Production	Relative Production	State with Greatest Production	Other States Producing
		Bu.	Per cent		No.
Irish Cobbler	1.085	7,513,998	15.47	Minnesota	16
Triumph	1.079	6,464,320	13.31	North Dakota	17
White Rose		4,269,265	8.79	California	12
Russet Burbank		3,466,162	7.14	Idaho	12
Green Mountain	1.084	3,326,721	6.85	Maine	7
Red McClure		1,029,900	2.12	Colorado	0
Russet Rural		489,836	1.01	Michigan	6
Early Ohio		284,389	.59	Minnesota	3
Burbank		47,776	.10	Oregon	2
Rural		42,005	.09	New York	5
Columbia Russet		25,000	.05	North Dakota	0
Brown Beauty		20,070	.04	Colorado	0
Earliest of All		7,000	.02	Oregon	0
Sir Walter Raleigh		2,034	.004	Pennsylvania	0
British Queen		1,850	.004	Oregon	1
Gold Coin		1,833	.004	Oregon	1
Early Rose		1,642	.003	Oregon	1
Beauty of Hebron		967	.002	Oregon	1
Idaho Rural		270	—	Idaho	0
Dakota Red		130	.03	Maryland	0
Unclassified		16,326	55.60	Minnesota	2
Total for old varieties		26,995,168			
Total production for all varieties for United States		48,575,155			

TABLE 2.—*New varieties on the certified seed-potato list in* 1948.

Variety	Specific Gravity (Maine, 1948)	Production	Relative Production	State with Greatest Production	Other States Producing
		Bus.	Per cent		No.
Katahdin	1.084	13,385,278	27.56	Maine	15
Chippewa	1.079	3,448,755	7.10	Maine	10
Sebago	1.082	1,517,345	3.12	Maine	14
Pontiac	1.077	937,252	1.93	North Dakota	11
Dakota Chief		497,494	1.02	North Dakota	2
Red Warba	1.080	493,205	1.02	Minnesota	6
Calrose	1.075	412,447	.85	California	2
Teton	1.085	220,613	.45	Pennsylvania	5
Sequoia	1.073	177,838	.37	North Carolina	10
Mohawk	1.086	94,366	.19	Maine	1
Houma	1.083	94,310	.19	Maine	3
Ontario	1.079	78,380	.16	New York	4
Warba		36,034	.08	Minnesota	3
Essex	1.074	31,537	.06	New York	2
La Salle	1.087	23,750	.05	North Dakota	1
Pawnee	1.084	21,272	.04	Colorado	2
Progress		19,718	.04	Nebraska	0
Russet Sebago		17,400	.04	Wisconsin	0
Erie	1.080	16,058	.03	Pennsylvania	1
Waseca		9,212	.02	Minnesota	0
Menominee	1.083	8,040	.02	Michigan	2
Satapa		7,097	.01	Minnesota	0
Kasota	1.077	6,003	.01	Montana	2
Chisago		2,727	.01	Minnesota	0
Chenango	1.081	2,500	.01	New York	0
Canus	1.071	2,500	.01	North Dakota	0
Marygold	1.079	640	—	Maryland	0
Empire	1.081	600	—	New York	1
Kennebec	1.086	200	—	Maryland	0
Potomac		150	—	Maryland	0
White Pontiac		40	—	Maryland	0
Total for new varieties		21,563,661	44.39		
Total production for all varieties for the United States		48,575,155			

Among the old varieties the Irish Cobbler was more widely grown than any other variety in the United States. In recent years it has been replaced in a number of sections by Katahdin and Chippewa. These varieties are not so early as the Cobbler, but they usually outyield it, and they are superior to it in market quality. The Triumph is an early red variety that is grown rather extensively in the Middle West but has

been replaced in parts of Florida, Alabama, and Louisiana by Sebago and Katahdin.

The Russet Rural is still quite widely grown in Michigan but is not so important as it once was in such states as Pennsylvania and New York. The Rural (Smooth Rural, White Rural) seems to be on its way out since only 42,000 bushels of certified seed of this variety was produced in 1948. It is very susceptible to *Fusarium eumartii*, or Z diseast, and to yellow dwarf. It has been replaced in parts of New York State and Wisconsin by Sebago which has a degree of resistance to both of these diseases. The Katahdin and Chippewa have also made inroads into Rural territory.

The White Rose predominates in the early-potato districts of California. It has been grown commercially at one time or other in other sections of the country but under different names. It was grown as the Jersey Giant in New Jersey, the Aroostook Wonder in Maine, and the American Giant in several states. It was replaced in these states by other varieties because of its tendency to produce under unfavorable conditions, knobby and hollow-heart tubers.

Green Mountain is still one of the leading varieties for yield and cooking quality if grown under the most favorable conditions, but it is highly susceptible to nearly all the potato diseases, especially late blight, mild mosaic, leaf roll and net necrosis. It has been replaced in some sections of Maine by Katahdin and Chippewa.

Russet Burbank (Netted Gem, California Russet, Idaho Baker) is the most extensively grown variety in Idaho and other states in the Pacific Northwest. When grown in sections to which it is adapted, its tubers have a high dry-matter content, which is preferred by most people for baking purposes. In recent years it has been attacked by a number of diseases that have reduced the yields and lowered the market quality. Among these are leafroll, which may or may not be the same as the virus leafroll of the Northeast, and a so-called die-early disease, which has not been definitely identified. This malady is thought by some to be caused by a species of Fusarium; others are of the opinion that Verticillium is the cause of the trouble.

Red McClure is grown for the most part in the San Luis Valley of Colorado. It seems to be well adapted to that section, and when graded carefully and washed, it usually brings a premium price on the Chicago markets.

To judge by the amount of certified seed produced in 1948, the other old varieties, with the possible exception of the Early Ohio, are grown to a very limited extent. The present status of the Dakota Red

is worthy of note. Not many years ago this variety was grown rather extensively under the name Red Skin or Jersey Red Skin in New Jersey, and for a fall crop on the Eastern Shore of Maryland and Virginia. It has been almost entirely replaced by the newer varieties, and as a result only 130 bushels of certified seed are available for the 1949 crop. McCormick and Spaulding Rose were quite widely grown at one time or other. They are no longer found on the certified seed lists. It is apparent that while new varieties are being introduced and increased, some of the old ones are on the way out as shown in table 1.

Some of the old standard varieties have excelled in yield and quality, but they have been very susceptible to diseases and insects. The new varieties are the result of research that has had for its objective combining the yielding ability and market and cooking quality of the old varieties with resistance to diseases and insects. The potato-breeding program of the United States Department of Agriculture began in 1910. In 1929 it was reorganized as the National Potato-Breeding Program, cooperating with a number of state experiment stations, some of which had potato-breeding programs of their own. Interest in the work increased until, in 1948, more than 35 state experiment stations were engaged to a greater or less degree in the enterprise. In that year increased appropriations made possible further expansion, and now a program exists that is truly national, as it is organized in every potato-growing section of the United States.

Katahdin was the first variety distributed under the present program. It was bred for resistance to mild mosaic. It has since shown some resistance to leafroll and is immune to net necrosis. Its adaptability is shown by the fact that, although it was not distributed until 1932, it now holds first place among all varieties grown in the United States. For a number of years the Irish Cobbler held first place in the amount of certified seed produced but it was displaced by Katahdin in 1947, and a year later nearly 28 per cent of all the certified seed produced was of the Katahdin variety (table 2). In addition, more than 5 million bushels of certified Katahdin were produced in the Maritime Provinces of Canada, which is about 45 per cent of all certified seed grown in those three Provinces. Its popularity is due to its wide adaptation, disease resistance, and excellent market quality.

Chippewa was released in 1933. It has not increased so rapidly as Katahdin. However, it did surpass Green Mountain in 1948. Chippewa, in the field, is immune to mild mosaic but very susceptible to leaf roll. It is a more consistent yielder than Green Mountain and matures from 10 days to 2 weeks earlier. In addition, Chippewa does not contract net

necrosis, the disease that is for the most part responsible for the decline of Green Mountain.

Sebago was released in 1938, not because it was perfect but because it had the best combination of characters available at the time. It produces high yields of tubers with satisfactory market and cooking qualities. It is more resistant to late blight than any of the old commercial varieties, although not nearly so resistant as some of the varieties released within the past 4 years. One of the most valuable characters observed so far is that its tubers are resistant to rots initiated by the late-blight fungus. It is more resistant to scab than Irish Cobbler or Green Mountain. Sebago is immune from mild mosaic in the field, and up to the present time its tubers have not developed net necrosis as a result of infection with the leaf-roll virus. Tests in the Hastings district of Florida have shown it to be resistant to brown rot, and it is grown in parts of New York state and Wisconsin becouse it is more resistant to yellow dwarf than Rural. There are about 1½ million bushels of certified Sebago in the United States, as you have observed in table 2, and nearly as much more in the Maritime Provinces of Canada.

Russet Sebago, a sport of Sebago, was selected and is being increased in Wisconsin. It is reported to be more scab-resistant than the original Sebago.

Houma was a United States Department of Agriculture selection sent to various experiment stations for test. It was selected in Louisiana because it gave a satisfactory performance in the Houma district of that state. However, it was found to be very susceptible to early and late blight, and although it still produces satisfactory yields other varieties are preferred in Louisiana. It is resistant to mild mosaic and is probably more resistant to leafroll than any of the varieties grown commercially at present. It has been grown to some extent in the New England section. About 94 thousand bushels of certified seed were produced in 1948, most of it in Maine as shown in table 2.

Sequoia was introduced in North Carolina because of its superior yields in the western part of that state. It was selected because of its resistance to hopperburn, and although thousands of seedlings and varieties have been tested for this character since Sequoia was released, none of them, so far, has shown the combination of high yield, good quality, and resistance to leafhopper injury found in Sequoia. It shows some resistance also to flea beetle injury. Its vines are moderately resistant to late blight, but its tubers are very susceptible to rot initiated by the late-blight fungus. About 178 thousand bushels of certified seed

of Sequoia were grown in 1948, with North Carolina showing the largest production.

Pontiac and its mutant variety Dakota Chief, or Red Pontiac, are late high-yielding red varieties. Pontiac was released in Michigan because it produced high yields on the muck soils of that state. It outyields and has a higher market quality than Triumph in Florida. Dakota Chief has been increased in North Dakota. In any district where a late red-tuber high-yielding variety can be grown these varieties should meet the requirements.

Kasota, a light red variety, was released jointly by Nebraska and Minnesota because of its tolerance to fusarium wilt, which is a destructive disease in some sections of the Middle West. Favorable reports have come from Nebraska and Minnesota, but the state reporting the largest amount of certified seed is Montana.

Menominee and Ontario originated from the same cross. They were both United States Department of Agriculture seedlings and were tested first at Presque Isle, Maine. They were bred for scab resistance and sent with a number of others to 20 cooperating states for further tests of their scab resistance and adaptation. Michigan Agricultural Experiment Station selected Menominee from the group, and the Cornell Station selected Ontario. They are both highly resistant to scab and somewhat resistant to late blight. In comparative tests, Ontario usually yields more and produces a smoother tuber, especially if the tubers are large. They are recommended for conditions in which a late variety can be used and in which scab is a limiting factor in the production of susceptible varieties.

Calrose is a late variety that was produced in Maine but sent to California because of its moderate resistance to late blight. It is a very high yielder, especially under irrigation where liberal amounts of water can be supplied.

Teton originated in Maine as a United States Department of Agriculture seedling. It was sent to several states for trial. It was found to be resistant to ring rot in tests in Wyoming and Maine. It was released from Wyoming but Pennsylvania has at present most of the certified seed of this variety. It is not immune from ring rot, and some experimental station people are reluctant to recommend it to their growers; but so far it has given excellent results in Pennsylvania.

Erie is a full sister of Teton. It was released in Ohio where it has been grown in a limited area. The largest production of this variety is in Pennsylvania. It is more resistant to ring rot than Katahdin or Green Mountain but not so resistant as Teton.

Mohawk is a United States Department of Agriculture seedling that was selected at the Cornell University Agricultural Experiment Station because of its high market and cooking quality. It was released to fill a demand for higher cooking quality in potatoes. Its production has not increased in New York State, but is increasing in Maine. It would have increased much more rapidly in the latter state except for the fact that it was not immune from net necrosis as it was first thought. As grown in parts of New York State and in Maine it produces tubers with excellent quality for baking.

Essex, Chenango, and Empire are varieties bred and released by the Cornell Station. They are highly resistant to late blight, but not immune as the early tests seemed to indicate. The Cornell Station has released nine others but none of them is found on the certified lists for 1948.

La Salle is an early white-tuber potato introduced by the Louisiana Agricultural Experiment Station. It produces tubers with somewhat better market quality than that of the Irish Cobbler, with which it was supposed to compete; but so far the La Salle has not replaced the Cobbler to any great extent, as can be seen by comparing the amount of certified seed of the two varieties.

Pawnee was released from the Potato Experiment Station of the United States Department of Agriculture, Greeley, Colo. In that district it gives satisfactory yields of high-quality potatoes. It is medium early but very susceptible to scab.

Progress is a red variety released in 1948 by the Nebraska Agricultural Experiment Station. Its chief advantage over Triumph is that its tubers do not crack in the harvesting operations so readily as do those of Triumph.

Waseca, Satapa, and Chisago are three varieties bred and released by the Minnesota Agricultural Experiment Station. There is a small amount of certified seed of each of these in Minnesota, but they are too new to predict how widely they will be grown.

Canus is the name given to a United States Department of Agriculture seedling that was sent to Canada a number of years ago in exchange for some varieties and seedlings from that country. The name is a word combining "Can" for Canada with "us" for United States. Canus has been promising in tests in Alberta and other sections of Canada.

Marygold and Potomac were United States Department of Agriculture seedlings released by the Maryland Agricultural Experiment Station. Marygold has outyielded Irish Cobbler in the spring-planted crops of the Eastern Shore of Maryland and Dakota Red in the fall crops of

the same district. It was put out to fill a need for one variety that would produce well in the spring crop, could be harvested in the summer, its tubers treated to break the rest period, and replanted immediately. So far, not enough seed of this variety has been produced to make it possible to determine whether or not it will meet the requirements of both crops when produced on a commercial scale. Potomac was released in the western section of Maryland where it has consistently outyielded the Rurals and Sebago but not the Sequoia. It is somewhat resistant to late blight in both vines and tubers, which gives it an advantage over Sequoia, the tubers of which are very susceptible to blight rot. However, Potomac has not been increased, as can be seen by the very small production of certified seed in 1948 as shown in table 2.

White Pontiac, a color mutation of the Pontiac, was selected and released by the Maryland Agricultural Experiment Station. It will probably produce high yields like the parent variety but will no doubt be susceptible to all the common diseases. For this reason it is difficult to see how it can compete with the high-yielding disease-resistant white varieties that are already in commercial production.

Kennebec was released by the United States Department of Agriculture and the Maine Agricultural Experiment Station. It is immune from the common forms of late blight in Maine and has shown a high degree of resistance in many tests throughout the United States. It has wide adaptation, as is shown by reports from South Africa, New Zealand, England, and Uruguay. Excellent yields have been reported, the only complaint being that the potatoes grow too large. However, the size can be controlled by closer planting or by using less fertilizer. The cooking quality of the tubers from the Maine plots has been rated from good to excellent. A degree of resistance to scab has been reported, but this is probably no greater than that found in Sebago; it was not bred for scab resistance. So far, it has never contracted mild mosaic or net necrosis. It is susceptible to leaf roll and spindle tuber, but no more so than Sebago and most of the other commercial varieties. As shown in table 2, only 200 bushels of this variety appear on the certified seed lists. There are several thousand bushels in Maine but it is in the hands of foundation seed growers who will increase it again before putting it on the open market. There should be seed available in the fall of 1949.

No variety has been distributed to growers that will meet the needs of all the cooperating states, and it is doubtful whether such an ideal variety will be produced soon. However, there was a sectional demand for most of the new varieties and their production has increased against hard competition because of special characters that give them a definite

advantage over the old varieties. In some of the new varieties the important objective for which they were bred has been reached. Kennebec, Sebago, Empire, Essex, and Chenango are resistant to late blight. Menominee and Ontario are resistant to common scab. Katahdin, Chippewa, Houma, Sebago, Kennebec, Mohawk, Ontario, and Menominee are resistant to one or more virus diseases; and Teton is resistant to ring rot.

A beginning has been made, and the new varieties that have already been released have been a factor in increasing the yields of potatoes in the United States from a little over 100 bushels an acre 25 years ago to more than 200 bushels in 1948. The results indicate much greater possibilities in breeding. We have available a large number of important characters that have not yet been combined in one variety, and each new combination should give us a new variety more valuable to some of the growers than any we now have. Those characters include wide adaptation; early, medium, and late maturity; smooth desirable shapes; shallow eyes; high yielding ability; high dry-matter content; and excellent cooking quality. Besides, we have seedlings that resist one or more of the following diseases and insects: mild mosaic, latent mosaic, rugose mosaic, leaf roll, net necrosis, yellow dwarf, late blight of the vines, tuber rot initiated by the late blight fungus, common scab, potato wart, brown rot, ring rot, hopperburn, flea beetle injury, and aphid injury. Such characters promise much for the varieties of the future.

POTATO VARIETY TESTING AND RELEASE PROGRAM IN MAINE

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An attempt has been made in Maine to develop a coordinated, systematic plan for potato variety development, testing, increase, and release. Such a plan has as its ultimate objective the orderly release to commercial certified seed potato growers of superior potato varieties with low initial virus disease readings. Several agencies are involved in this cooperative plan, namely: the Bureau of Plant Industry of the

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United States Department of Agriculture; the departments of Plant Pathology, Entomology, and Agronomy of the Maine Agricultural Experiment Station; and the Division of Plant Industry of the Maine Department of Agriculture. All agencies involved in this program have agreed upon certain areas of responsibility. Based on three years' experience it appears that the program is functioning effectively.

Varietal Development

Operating at Beltsville, Maryland, geneticists with the Bureau of Plant Industry, Soils and Agricultural Engineering of the United States Department of Agriculture carry the responsibility for developing new potato varieties. While this breeding program is national in scope, the particular needs of the Maine potato industry receive recognition as do the needs of other producing areas. Seedlings produced at Beltsville are planted on the Maine Agricultural Experiment Station farm in Chapman, under the supervision of personnel of the Bureau of Plant Industry. Annually, about 20,000 first-year seedlings are grown on the Chapman farm in single hill lots. Observations are made during the growing season and at harvest time on plant and tuber characteristics with a special effort being made to retain those seedlings which have commercial possibilities or represent potentially desirable parent stock. At the end of this first year only about ten to fifteen per cent of the seedlings are saved. In the second year the seedlings which have been saved are grown in ten hill lots and are tested for fertility, maturity, and virus content. Seedlings with commercial possibilities for any of the numerous quality factors, such as yield, maturity, dry matter content and disease or insect resistance in which various states are interested, are selected for further trials by and for state experiment stations.

Varietal Testing

In Maine, the preliminary testing program is conducted by Donald Folsom and Reiner Bonde, Plant Pathologists with the Maine Agricultural Experiment Station; Geddes Simpson, Entomologist with the Experiment Station; and E. S. Schultz, Pathologist with the Bureau of Plant Industry. Essentially these trials are designed to select varieties showing resistance to the more serious diseases and insect pests occurring in Maine. Resistance of seedlings to late blight, bacterial ring rot, leafroll, common scab, various mosaic complexes, and the green peach aphid are of particular concern.

Varieties showing superior qualities of resistance as compared with standard varieties now in use, and having apparent acceptable commercial qualities are then placed in the yield and adaptability trials

under the supervision of the Agronomy Department of the Maine Station. These yield-adaptability trials are conducted at six different locations in Maine on commercially operated potato farms. Although plot layout with replications and hand spacing of uniform sized seed pieces are carefully made, the plots are handled by the farmer cooperator as part of a commercial field and in his customary manner insofar as fertilization, disease and insect control measures, and cultivation are concerned. Not in all cases are cultural methods at the best possible levels, but it has been decided to subject the varieties to conditions commonly in use. Geographically these trials are run in all sections of Maine where potatoes are of major importance.

Yields are taken and specific gravity determinations are made at harvest time. The following summary tables of the 1948 trials illustrate the differences which occur from location to location within Maine.

Variety Release

In 1949 the only unnamed seedlings carried in the trials which had been grown in 1948 were N.D. K-5, B76-43, B61-3, and B294-22. It was decided by the agencies involved that the other seedlings did not have outstanding commercial possibilities. It is planned to release only those varieties which over a three-year period show distinctly superior qualities of diseases or insect resistance and have high yielding ability and adequate quality. Certainly the emphasis will be to name only outstandingly good varieties and releases will be kept to a minimum.

Reservoir stocks of all unnamed varieties in the yield trials are maintained at Aroostook Farm. These are rogued carefully to keep the disease content of the stocks at a minimum. Once it has been decided by all concerned to name and release a variety, the reservoir stocks are taken to the Seed Board Farm at Masardis. This farm is owned by the State of Maine, and is operated primarily as a seed source farm for foundation seed growers. Five hills of each unnamed seedling in the yield trials are carried on this farm as soon as it has been decided to increase a variety for state-wide yield testing. These, too, serve as a seed reserve for potentially promising seedlings. A Seed Board composed of five seed growers appointed by the Governor of Maine is the governing group, but the day by day operation of the farm is under the direction of E. L. Newdick, Division of Plant Industry, Maine Department of Agriculture. This farm functions to maintain disease-free seed stocks of different commercial varieties as well as to increase lots of new varieties to a point where they can be sold to farmers. Release of a new variety from the Seed Board Farm is made generally to foundation

TABLE 1.—*Comparison of yield of eighteen potato varieties at six Maine locations in* 1948.*

Bushel per Acre

Variety	Van Buren	Presque Isle	Houlton	Patten	Exeter	Bethel	Av. All Locations	Av. 5 Locations 1947
Ontario	642.7	464.2	445.4	800.4	642.4	601.9	599.5	570.6
Gr. Mt.	667.3	469.4	510.1	803.6	566.6	529.4	591.1	602.6
B76-43	660.2	469.1	366.9	700.7	652.5	656.9	584.4	not grown
Kennebec	654.1	443.6	444.2	758.4	555.0	612.8	578.0	674.5
Teton	604.1	413.0	439.3	715.9	616.1	534.5	553.8	604.6
Chippewa	634.2	409.8	340.9	694.4	561.0	573.0	535.6	558.4
N.D. K-5	528.4	406.9	389.3	666.6	543.5	613.5	524.7	580.9
B61-3	605.2	387.9	358.1	667.7	487.2	584.9	515.2	569.1
B294-22	578.8	375.4	328.9	667.0	516.4	565.9	505.4	not grown
Mohawk	595.3	393.4	328.0	618.2	538.3	414.9	481.4	542.3
Katahdin	547.6	331.1	333.4	649.4	456.6	499.9	469.7	520.5
Irish Cobbler	517.8	341.3	264.3	620.8	559.6	501.6	467.6	538.5
Empire	520.0	377.2	354.9	649.4	416.4	409.1	454.5	not grown
X1276-185	521.4	368.7	301.3	604.4	441.0	460.1	449.5	477.6
B301-90	497.2	366.4	271.6	660.0	471.6	421.8	448.1	not grown
B301-29	450.8	300.3	335.4	593.1	501.4	451.7	438.8	not grown
B301-43	522.0	345.6	291.1	608.9	437.0	402.7	434.6	not grown
B301-20	458.3	280.8	203.4	481.6	329.2	336.1	348.2	not grown
L. S. D. 5 per cent	57.0	33.0	94.6	66.5	115.0	77.9		

*All potatoes were planted nine inches apart in the row. Six replications, 30 hills per individual plot, fertilized with complete fertilizer furnishing a minimum per acre of 100 lbs. of nitrogen in about 2-3-4 ratio.

TABLE 2.—*Comparison of specific gravity of eighteen potato varieties grown at six Maine locations in 1948. Specific gravity by weight in water method.**

Variety	Van Buren	Presque Isle	Houlton	Patten	Exeter	Bethel	Average
Ontario	1.0693	1.0790	1.0714	1.0745	1.0898	1.0678	1.0753
Gr. Mt.	1.0803	1.0838	1.0858	1.0904	1.0970	1.0780	1.0860
B76-43	1.0834	1.0907	1.0796	1.0915	1.0955	1.0774	1.0864
Kennebec	1.0774	1.0861	1.0779	1.0789	1.0930	1.0712	1.0808
Teton	1.0766	1.0855	1.0759	1.0752	1.0851	1.0687	1.0778
Chippewa	1.0678	1.0802	1.0709	1.0727	1.0730	1.0633	1.0713
N.D. K-5	1.0710	1.0786	1.0716	1.0701	1.0798	1.0632	1.0724
B61-3	1.0781	1.0908	1.0778	1.0832	1.0931	1.0741	1.0829
B294-22	1.0814	1.0880	1.0828	1.0708	1.0956	1.0700	1.0813
Mohawk	1.0776	1.0859	1.0826	1.0798	1.0946	1.0731	1.0823
Katahdin	1.0727	1.0840	1.0778	1.0782	1.0857	1.0647	1.0772
Irish Cobbler	1.0784	1.0854	1.0830	1.0877	1.0801	1.0730	1.0813
Empire	1.0764	1.0811	1.0829	1.0818	1.0927	1.0739	1.0815
X1276-185	1.0729	1.0816	1.0747	1.0742	1.0788	1.0651	1.0746
B301-90	1.0693	1.0786	1.0711	1.0720	1.0760	1.0602	1.0712
B301-29	1.0688	1.0838	1.0682	1.0707	1.0811	1.0644	1.0728
B301-43	1.0764	1.0866	1.0800	1.0759	1.0823	1.0688	1.0783
B301-20	1.0710	1.0833	1.0786	1.0801	1.0833	1.0681	1.0774
Average	1.0749	1.0841	1.0774	1.0786	1.0864	1.0690	
L. S. D. 5 per cent	.0041	.0067	.0064	.0042	.0040	.0019	

*Average of six replications for each variety at each location.

seed growers first. On foundation seed farms the variety is planted by tuber unit methods and rogued by employees of the State Department of Agriculture. Finally, seed grown by foundation growers can be sold only in Maine providing a market is available. Ordinarily foundation seed is purchased by growers of certified seed.

The program of variety release is entirely self supporting with the farmers who secure stocks of a new variety paying the costs involved.

POTATO VINE KILLING IN PRINCE EDWARD ISLAND[1]

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During the past several years the elimination of potato vines by physical or chemical agencies has been progressing rapidly into the realm of common procedure. Many chemicals and machines have been developed for the specific purpose of destroying the vines prior to harvesting the crop. Experiments have been and are being conducted in many regions, and a few papers have appeared. This recent and intense interest in vine killing almost deludes us into believing that the idea is a modern one, but if we examine the literature we shall find that its roots go back to a great many years. We have, in this present decade, merely revived and developed some facts and ideas of rather ancient vintage. In 1887 Jensen (6) suggested that the crop be left in the ground until two weeks after the stalks were dead so as to reduce infection from contact of the tubers with partially blighted foliage. The results of his experiments and observations were substantiated on this continent by Jones and Morse (8), whose work has been summarized by Jones, Giddings and Lutman (7). Clinton (3) observed that outbreaks of rot usually followed slight but long drawn-out attacks of late blight, and that losses were negligible in seasons when severe epiphytotics brought about an early and complete death of the vines. Other early authors such as Stewart (12) and Osmun (10) have recorded similar experiences.

During the period 1916-1919 a very considerable amount of in-

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vestigational work was conducted at that which was then known as the Plant Pathological Field Station at Charlottetown, Prince Edward Island, by Paul A. Murphy, who later continued his studies in Ireland. The results of his experiments were published in an excellent paper in 1921 (9). A brief review of his findings and suggestions will provide us with an interesting historical background to the subject and perhaps make us realize that we have ignored some very valuable information for two decades. Murphy reported that the following conclusions seemed justifiable:

1. The danger of late blight rot originating from the foliage and surface soil during digging is greater than that occurring while the potatoes are in the ground.

2. The surface soil is a more serious source of infection at harvest-time than partly blighted foliage.

3. Infection may be caused by the soil certainly nine days after the stalks are removed, and probably longer, but not thirty-four days afterwards. The exact time was not determined.

4. Rot is reduced considerably by the removal of the foliage a sufficient period (probably not less than two weeks) before harvesting.

In a consideration of the practical applications of his findings Murphy made some very poignant statements and these have formed the bases of our later work. He pointed out, "That where blight breaks out late in the season on potatoes which were previously healthy, and where it is believed the tubers are still free from infection, there are good indications that the safest course to follow is to remove the stalks and not to dig the crop until at least two weeks later. This practice is new and it is desirable that experimentalists, and growers who have trouble with rot, should give it a trial on a small scale in conjunction with the best spraying possible. It is possible to cut off the stalks with a mower and then rake them off the field. It is believed that a better way would be to spray the plants with a poisonous chemical in order to reduce the danger of shaking down conidia from the leaves and disturbing the soil. The spraying method has not been tried but it will probably be found that the formula recommended for killing wild mustard will be found effective, that is, 10 pounds of copper sulphate in 40 gallons of water. It has been found that the foliage of potato and wild mustard react similarly to several chemicals, for instance to 15 per cent solutions of magnesium chloride, nitrate of soda, and potassium chloride. It is probable that a little ingenuity would discover better chemicals than these, among which might be suggested

bleaching powder or soluble arsenic compounds like sodium arsenite which are used as commercial weed-killers."

The seed that Murphy sowed was not entirely lost, and in Prince Edward Island it was not unusual, in a year with a prolonged growing season, to see a farmer "burning off the tops" by spraying them with a concentrated solution of copper sulphate in order to facilitate digging operations. However, although the practice was recognized as excellent, little or no attention was directed to it, and no definite investigational work was undertaken until 1941, when some preliminary tests were carried out. The possibility of using certain common chemicals such as ammonium nitrate, sodium nitrate, ammonium sulphate, cupric sulphate, and sulphuric acid was investigated (1). Each of these has been discarded because of certain undesirable features. Sulphuric acid is without doubt a very quick and efficient vine killer, but because of its great chemical activity it is dangerous to use and special equipment must be employed to make the applications. It was found necessary, then, to search for more suitable chemicals.

Some farmers in Prince Edward Island were adding a small quantity of Handy Killer, a concentrated solution of sodium arsenite, to Bordeaux mixture for the purpose of controlling the Colorado Potato Beetle. It was known that serious burning of the foliage would result if this chemical was applied alone or with a neutral fungicide. It was found that a satisfactory but slow destruction of the foliage could be obtained with this chemical and it soon became, under various trade names, a widely used vine killer. In Prince Edward Island, where it is now almost the only type of vine killer used, two quarts in eighty gallons has been found satisfactory for killing maturing vines, but it is recommended that the sprayer be driven both up and down the rows to assure maximum coverage. Higher concentrations are needed when young vigorous vines are to be eliminated. Recent greenhouse and field tests (2) have shown that the inclusion of a suitable oil in the sodium arsenite spray increases the rate of its killing action, but results have been variable. In 1947 excellent kills were effected when the vines were sprayed with a mixture containing two quarts of a sodium arsenite vine killer and four gallons of waste crankcase oil in eighty gallons of water. The spray was prepared by stirring the arsenical and oil together, adding the resulting mixture to the sprayer tank, and finally adding the water while the agitators were turning. This method of mixing emulsified most of the oil. This mixture killed the vines much more rapidly than similar concentration of sodium arsenite without oil, and killing rates were comparable to those effected

by Dowspray 66 Improved (1 gal. — 80) and Sinox General (1 qt. + 3 gal. oil — 80).

In 1948 three preparations of sodium arsenite were compared: 2 qts. — 80, 2 qts. + 10 lbs. sodium chloride — 80, 2 qts. + 4 gals. waste crankcase oil — 80. The plants in plots treated with the salt mixture were the first to show a reaction, but later the differences in killing rates were not great, the oil mixture not showing the outstanding superior effectiveness observed in 1947. The salt mixture was slightly better than the sodium arsenite alone.

Three preparations of Dowspray 66 Improved were also tested in 1948: 1 gal. — 80, 1 gal. + 2 lbs. aluminum sulphate — 80, 2 gals. — 80. Here again differences in killing rates were not great. The aluminum sulphate made a slight difference in the effectiveness of the chemical, but the use of an additional gallon of Dowspray 66 was not justified by the results. In 1947 two gallons of Dowspray were greatly superior to one. A ten per cent mixture of the British vine killer Lotemcide was very effective. Plants sprayed with this material wilted and blackened almost immediately and in forty-eight hours all the leaves and almost all the stems were dead. It was evident that a lower concentration would be satisfactory.

In 1948 the plants were approximately the same age and the sprays were applied on almost the same date as in 1947. The only observed variable factor was the weather. Weather data for the periods of vine killing are presented in table 1, in which it is indicated that the period in 1948 was characterized by lower temperatures, less sunshine, higher humidity, and greater precipitation. This cool, cloudy and damp weather probably slowed down the killing action of the vine killers, and tended to lessen the differences in their killing rates. During the eight years that we have been studying vine killing we have observed that the plants are killed down much quicker when the period is sunny and hot.

The artificial destruction of potato vines has introduced a new problem: the premature killing of vines may induce a stem-end browning and vascular discoloration of tubers. This phenomenon has not been observed in Britain (14), where chemical vine killing has been practiced for many years, but it is regarded in a serious light in some regions on this continent. In 1946, when vine killing was first used on a large scale in British Columbia, from 50 to 100 per cent of the tubers from treated fields developed vascular discoloration (1). The growers, who had treated about 1000 acres were greatly worried because they feared that their potatoes would not be accepted on their

TABLE 1.—*Weather data for 1947 and 1948 periods of vine killing*

		1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day	Mean
Min. Temp.	1947	48	57	62	68	55	63	66	59.9
	1948	61	59	58	60	60	50	44	56.0
Max. Temp.	1947	68	66	83	86	80	67	74	74.9
	1948	77	69	72	77	67	60	60	68.8
Hours Sun	1947	10.4	8.3	8.7	9.6	9.6	10.3	5.5	9.4
	1948	2.0	0.0	5.0	8.5	9.6	8.8	0.0	4.8
Rel. Humidity	1947	67	71	83	82	79	81	81	77.7
	1948	89	87	72	74	74	73	83	79.3
Precipitation	1947	0.03	—	—	—	—	0.14	—	—
	1948	trace	trace	trace	—	—	0.16	0.33	—

seed market in the Pacific Coast States. In Ontario, likewise, pronounced stem-end browning was found associated with the treatments (1).

When these reports from our sister provinces were brought to our notice, we decided to direct some attention to a study of the effects of vine killing on the tubers. Some progress has been made but it is still not possible to present a clarified explanation for this unfortunate phenomenon. It is likely, however, that more than one predisposing factor plays a part in inducing the condition. These factors may include: (1) the rapidity of the kill, (2) the type of chemical used, (3) the character of the season, and (4) the age of the plants.

Hoyman (4, 5) reported that tuber discoloration was positively correlated with the rapidity of the kill under the conditions of his experiments in North Dakota. Richardson (11) has made similar observations in Ontario; and in British Columbia, where induced tuber vascular necrosis was abundant and severe in 1946, it was noted that in fields where the vines were killed slowly the amount of discoloration was no greater than normal (1). The experiments in Prince Edward Island have consistently indicated that the rapidity of the kill is one factor in inducing tuber vascular discoloration. It is a recognized fact that a quick-killing frost may induce the condition, and our tests have shown that tubers from plants whose vines have been mechanically cut off at ground level exhibit a much greater incidence of stem-end browning than tubers from untreated check plants, or from plants destroyed by slow-acting herbicides.

Vine killers in which the active principle is a dinitro compound have always shown a considerable propensity to induce tuber vascular discoloration in the tests conducted in Prince Edward Island. Steinbauer (13) has observed a similar tendency, and Hoyman (4) has reported a brown discoloration of the vascular tissue two days following the application of Dowspray 66 Improved (dinitro ortho secondary butyl phenol). This chemical was selected for some special studies.

In the winter of 1947-1948 green-sprouted sets of the variety Green Mountain were planted in 8-inch pots on the 5th of January, and treatments were begun on the 23rd of February—fifty days later. Treatments and results were as follows:

Treatment 1. One leaf was held for one minute in a 1-25 dilution of Dowspray 66 Improved, a different leaf being treated each day. It was observed that the stems weakened and split at the point of attachment of the petioles of treated leaves, causing the plants to wilt and fall over. After four treatments the plants, which were not large,

TABLE 2.—*Percentage of tubers showing prominent discoloration in vine killing tests,* 1948

Chemical	Concentration per 80 Gallons	After 14 Days	After Six Weeks in Storage
Check	———	1	6
Sodium arsenate	2 qt.	8	17
Sodium arsenite + oil[1]	2 qt. + 4 gal.	12	19
Sodium arsenate + salt	2 qt. + 10 lb.	17	29
Dowspray 66	1 gal.	8	28
Dowspray 66 + aluminum sulphate	1 gal. + 2 lb.	6	35
Dowspray 66	2 gal.	18	41
Lotemcide	8 gal.	16	56
Tops cut off	———	11	40

[1]Waste crankcase oil.

were all prostrate and nearly dead, death occurring in seven days. The tubers were harvested, brushed clean, and examined on the 1st of March. Stem-end browning was severe in 14.8 per cent of the tubers.

Treatment 2. One cubic centimeter of Dowspray 66 Improved was distributed over the soil surface in each pot and the plants were watered immediately. The treatment was repeated on each of the succeeding three days. On the third day the veins of the leaves were darker than normal and chlorosis was apparent in the leaf tissue along the main vein. The chlorotic areas progressed rapidly out along the lateral veins, the plants wilted, and on the fourth day all the plants lay prostrate. On the seventh day 50 per cent of the plants were dead. The entire vascular ring was discolored in 92 per cent of the tubers.

Treatment 3. Three cubic centimetere of the chemical were applied to the surface soil in one application, and the plots were watered immediately. The symptoms were similar to those described under treatment 2. The entire vascular ring was discolored in 100 per cent of the tubers.

Treatment 4. Absorbent cotton was packed on the soil and held in place by means of a waxed cardboard disk; the plants were inverted in a 1-40 dilution of the chemical, allowed to drain, and replaced on the benches. This method prevented any of the chemical from reaching the soil. The plants were watered every day until they were dead. The effects of the treatment were visible at once, and within one hour the leaves were soft and black and all plants were prostrate.

Death was complete on the third day. Stem-end browning was severe in 34.5 per cent of the tubers.

Treatment 5. The method employed here was similar to that of treatment 4 but the plants were not watered for three days before the treatment or afterwards. At the end of one hour the plants showed almost no effects and death was not complete until the fourth day. Stem-end browning was severe in 77.4 per cent of the tubers, the percentage being more than double that recorded for the tubers of treatment 4. It was indicated, therefore, that stem-end discoloration induced by vine killing is favored by drought.

Treatment 6. These plants were allowed to die for lack of water. Stem-end browning was severe in 7.4 per cent of the tubers.

Treatment 7. The plants were kept watered and healthy until harvested on the 1st of March. Stem-end browning was severe in 4.0 per cent of the tubers.

Some of these treatments were studied under field conditions during the past summer. the treatments being: (1) one leaf dipped daily in a 1-25 dilution of Dowspray 66 Improved. A treatment was of ten seconds' duration; (2) One cubic centimeter of the commercial chemical applied to the soil under each plant; (3) Three cubic centimeters per plant applied to the soil; (4) Five cubic centimeters per plant applied to the soil; and (5) No treatment. The plots, of Green Mouutains, were planted on the 26th of May and two plots of fifty plants each were used for each treatment. The plants were large and vigorous when the leaf treatments were begun on the 24th of August and the severe effects observed on the much smaller greenhouse plants were not apparent. From the 24th of August to the 23rd of September eighteen leaf treatments were made but only 17 per cent of the plants were killed. The soil treatments were made on the 2d of September. No effects of the soil treatments were visible on the foliage. The plots were dug on the 28th of September and the tubers were examined at once. The percentage of severe stem-end browning in the tubers was as follows: Check, 0.0; leaf treatment, 6.0; 1 cc. on soil, 6.0; 3 cc. on soil, 7.0; and 5 cc. on soil, 10.0.

In a test conducted in 1947 (2) it was shown that the amount and intensity of discoloration in tubers from plots killed at different stages of development with Dowspray 66 Improved increased uniformly with the age of the plants. Replicated plots were killed on the 11th and 27th of August, the 8th and 22nd of September, and the percentage of tubers showing prominent stem-end browning was 3.3, 21.3, 36.0 and 43.0, respectively.

During the past season two tests were carried out to study the effect on the tubers of killing plants at different ages. One series of replicated plots was planted on the 19th of May and the chemical was applied 70, 85, 100, and 115 days after planting. In the other series the plots were planted at 15-day intervals beginning on the same date. All plants in this second series were killed on the same day, that of the last killing in the first series. Consequently, the plants in the second series were also killed 70, 85, 100, and 115 days after planting. The variety Green Mountain was used. Two gallons of Dowspray 66 Improved in eighty gallons of water were used for all applications. The spray was delivered at a pressure of 325 pounds; the machine was equipped with four nozzles per row and driven both ways of the rows so that rather heavy applications were made. One hundred tubers from each plot were examined by removing one or more thin slices from the stolen end fifteen days after each application. It was quite obvious in both experiments that stem-end discoloration increased as the plants approached maturity as is shown in table 3.

Summary

1. The killing of potato vines prior to harvesting the crop has been widely practiced in recent years but the theory goes back many years. In 1887 Jensen, working in Europe, suggested leaving the crop in the ground until two weeks after the tops were dead as a sanitary measure against late blight tuber rot, and his theories were substantiated by the experiments of several workers on this continent early in the present century. Paul A. Murphy, working in Prince Edward Island during the First World War, proposed cutting and removing the vines or spraying the plants with chemicals such as cupric sulphate or sodium arsenite.

2. Sodium arsenite kills the plants slowly, but the addition of a suitable oil such as waste crankcase oil results in a more effective spray. The addition of common salt (sodium chloride) also increases the phytotoxicity of sodium arsenite vine killers.

3. A new British product, Lotemcide, gave a very rapid and complete destruction of the foliage when used at a concentration of 10 per cent. A lower concentration would be satisfactory.

4. A discoloration at the stem end and in the vascular system of tubers may be induced by killing the vines.

5. The factor or combination of factors that may be correlated with the discoloration has not been determined satisfactorily. It is probable that more than one factor plays a part in inducing the condi-

TABLE 3.—*Amount and intensity of discoloration in tubers from plants killed at different ages with dinitro ortho secondary butyl phenol,* 1948.

Method	Age When Killed (Days	Per cent Free	Per cent Incipient	Per cent Moderate	Per cent Severe	Rating
Planted at 15-day intervals	70	7	38	44	11	12.6
	85	1	9	58	32	16.0
	100	1	8	51	40	16.4
	115	0	1	49	50	17.4
Killed at 15-day intervals	70	12	43	30	15	11.8
	85	3	19	43	35	15.3
	100	1	2	48	49	17.2
	115	0	1	44	55	17.7

tion. These factors may include: (1) the rapidity of the kill, (2) the type of chemical used, (3) the character of the season, (4) the age of the plants.

6. In Prince Edward Island it has been observed that tuber discoloration is correlated with the rapidity of the kill.

7. Tubers harvested from untreated cut vines have shown a greater amount of stem-end browning than tubers from untreated check plants, or from plants killed by slower-acting chemical vine killers.

8. Vine killers in which the active principle is a dinitro compound have shown a considerable propensity to induce tuber vascular discoloration.

9. The amount of moisture available to the plants may affect the amount of tuber discoloration, the tubers from plants killed under drought conditions exhibiting the greatest injury in greenhouse tests.

10. Experiments conducted during the past two seasons have indicated that the amount and intensity of discoloration in tubers from plants killed at different stages of development with dintro or the secondary butyl phenol increases uniformly with the age of the plants.

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SECTIONAL NOTES

Colorado

Colorado has a big crop again this year. The acreage in 1949 was considerably less than last year, but in general the yields have been high. It is difficult to write about potato yields for Colorado without reminiscing into the past year, or reflecting what has happened over the years. The average acreage for the state from 1928 to 1932 was 104,000. The average production for the state during those years was 14,500,000 bushels, or an average per acre yield of 149 bushels. In 1949, the estimated acreage planted is 67,000, and the total yield is in excess of 16,000,000 bushels, or an average per acre yield of 240 bushels or more. The weather during harvest has been much more favorable than it was at planting time. During the latter part of May and the first half of June, Nature bestowed upon us more rainfall than we usually experience during six months' time. This had a double effect in that it prevented the early crop from being cultivated and sprayed, and it also prevented the late crop from being planted until quite late. Along with too much rain early, there was a severe infestation of psyllids. The psyllid is a small insect common to the areas of low rainfall, and which, when occurring in large numbers, can make all the other potato insects appear as "sissies" from the standpoint of damage done. These insects, by their feeding, inject a poison into the vines, with the result that tubers either fail to form, may form a string of tubers on a single stolen, or may be so malformed that the potatoes are not worth digging. Some few fields in Colorado were so badly damaged that harvesting was discontinued. The answer to these pests is DDT or sulphur, or both. Some years ago it was discovered that sulphur dust or lime sulphur spray, acting as a repellent, would control psyllids, and since the development of DDT, the psyllid has quite largely ceased to be a serious problem. However, this year there was an extra heavy infestation, and had it not been for DDT, it is questionable whether or not there would have been any potatoes in Colorado.

Nature made up for the late planting by not producing a killing frost in most of Colorado until the 11th of October, which is an unusually late date for even the lower elevations. Consequently, the average yield for the late crop has been high. There were, on the irrigated lands, many yields of more than three hundred sacks (one hundred pound sacks) per acre, several yields of four hundred sacks, and one or two yields of five hundred sacks or more. In general, the quality is good throughout most of the state. There was a small amount of field frost during the

latter part of harvesting, but the percentage of field frost is much smaller that a year ago.

There were 6,200 acres of all varieties entered for certification this year. All the field and bin inspections are completed and the winter test samples have been collected. These samples are planted about the 15th of December, at Brownville, Texas. Disease readings are made some time in February. Winter testing is compulsory in Colorado if tags are to be issued, or if the seed is to be recertified.—CECIL W. FRUTCHEY.

MAINE

The following paragraphs taken from a local news bulletin says: "Haulings and offerings from the growers are very light. Street price bulk barrel measure from the growers continues too high and the dealers are unable to sell for prices high enough to pay their operating costs. Therefore, many warehouses remain closed and growers will not start selling freely until after the first of the year when support prices are higher. Some potato men are concerned about the light daily shipment out of Maine. Of course, this could increase quickly if the prices advance to about January support levels.

The Certified Seed demand is showing some improvement and we have sold more seed in the last few days than for several weeks.

The Marketing Committee of the Production Marketing Administration met again and changed their recommendation to the Secretary. They now recommend a size specification on table stock from Maine for the balance of the season of 2″ minimum to 4″ maximum, with the B's and those over 4″ withheld from the markets.

All starch factories in Aroostook County are now doing business and will take care of these B's, culls, and over-size potatoes."

The potatoes are apparently coming out very good. There is relatively little shrinkage and there are not so many over-sized potatoes as we thought there would be. Maine's yield of 425 bushels sets an all-time high. Shipments this year have reached 3771 cars, of which only 55 were government purchases. Last year at the same time Maine had shipped 6743 cars, of which 5474 cars were government purchases. Certified Cobblers are being quoted at $3.00 per cwt. F.O.B. Presque Isle for February delivery; Certified Katahdins and Chippewas about $2.45.—VERNE C. BEVERLY.

NEBRASKA NOTES

The harvesting of late main crop potatoes in Nebraska was practically completed by the 15th of October, with a few stragglers still in op-

eration the following week. As a whole, the harvesting period was quite satisfactory from the weather standpoint, although parts of the territory had heavy rains, which accounted for delays for some growers. Light frosts prior to harvest, killed the vines and matured the tubers, so that there was little difficulty with cracking, as is generally the case with the Triumph variety. In addition to the maturity of the potatoes, the prevalence of scab was much lighter than usual, resulting in the general improvement of quality as compared with previous seasons. Shippers and growers alike report that the percentage of U. S. No. 1 grade is highly satisfactory through most of western Nebraska.

The final tuber inspection of Certified potatoes confirms the opinion of shippers and growers. This inspection is about completed at this writing, and indicates a larger tonnage of Blue Tag quality than in 1948, despite a reduction in total tonnage.

The reduction in total tonnage is accounted for by an extremely early frost in parts of western Nebraska, and an early blight epidemic that knocked down the vines a week or ten days earlier than usual.

Referring to the notes from Nebraska during the summer, it will be observed that psyllid yellows was the most serious problem encountered. This insect trouble is manifested by an abortive growth of the vine, excessive set and mal-formed tubers. The effect on the tubers can be observed in examination of the harvested product. Fortunately, this trouble does not affect the seed quality or the following crop. The reduction in yield, of course, is quite apparent in some cases.

Shipments of table stock have been light up to this time. Growers are apathetic, as they feel prices are too low. Certified seed shipments are just beginning, the earliest going to the Rio Grande Valley of Texas. This heaviest movement to the deep south usually comes after the first of the year.—Marx Koehnke.

Oregon

Harvesting operations have been completed. Approximately 1400 acres—Russets 929; White Rose 485—met seed certification requirements. The insect population was very light and as a result the seed was of excellent quality. The local potato association program of using better seed, dusting or spraying for insect control, planting only on clean and built-up soil, and careful field examination throughout the year have apparently been very instrumental in seed improvement.

The commercial potato crop came out fairly well even though extremely heavy frosts occurred in early summer and late spring. The yield

will be considerably below that of 1948 and the percentage of number 1's will be a little less. In general, however, growers are quite well satisfied with the outcome, a late fall season has helped tremendously. —C. A. HENDERSON.

A total of 924 acres of Russets (Netted Gems) and 450 acres of White Rose have met all certification requirements to date. This acreage will produce approximately 350,000 sacks of certified seed. However, this entire tonnage may not go for certified seed, inasmuch as the bakers may be taken out and sold commercially on several large lots of Russets.

The marketing agreement in effect here seems to be working out in good shape and growers of central Oregon and northern California (Tulelake District) approved it by an overwhelming vote. This is the second year of active operation of the Central Oregon and Northern California Marketing Agreement and growers are finding it most helpful to them.—C. A. HENDERSON.

DOMINION OF CANADA

The 1949 potato crop in Canada is estimated at approximately 82 million bushels. This is a reduction of approximately 10 million bushels from that produced in 1948. No estimate has been made of the amount of certified seed produced but it is expected that it will be somewhat in excess of 13 million bushels. 65,000 acres of all varieties passed field inspection in 1949 as compared with 57,000 in 1948. This is the highest acreage passed on record. The entire crop has been harvested and the yields in most places are reasonably good. In Prince Edward Island the yields are higher than they were last year, whereas in some of the other provinces the yields are the same or slightly less than those obtained in 1948. Large quantities of certified seed are moving to foreign countries by rail and boat. The first car-lot shipment of the new variety 'Canus' moved from Manitoba to British Columbia in October. The variety produces a high percentage of medium-sized marketable tubers which have an attractive skin. There has been an excellent demand for the Pontiac variety this year and it is expected that more will be grown in 1950.—J. W. SCANNELL.

PROGRAM OF THE ANNUAL MEETING OF THE POTATO ASSOCIATION OF AMERICA

December 7, 8, 9, 1949

HOTEL PHILLIPS

KANSAS CITY, MISSOURI

President, O. D. BURKE, Pennslyvania State College, State College, Pa.

Wednesday Morning, December 7, Hotel Phillips (see bulletin board for room number) 9:30 A. M.

A. G. TOLAAS, *Presiding*

1. *The Spread of Potato Virus X by the Cutting Knife* R. H. LARSON, University of Wisconsin, Madison, Wis.
2. *Physiological Internal Tuber Necrosis—Reaction of Potato Varieties* R. H. LARSON, University of Wisconsin, Madison, Wis.
3. *Field Tests of Some New Potato Fungicides* J. H. MUNCIE, Michigan State College, East Lansing, Mich.
4. *The Tolerance of Potato Foliage to Zinc* WM. G. HOYMAN, North Dakota Agricultural Experiment Station, Fargo, N. D.
5. *The Expression of Leaf Roll Symptoms in the Potato as Influenced by Plant Nutrients* H. M. DARLING and K. C. BERGER, University of Wisconsin, Madison, Wis.
6. *A Study of Factors Influencing Symptomatology of Bacterial Ringrot of Potato and Distribution of the Pathogene through the Host* ARDEN F. SHERF, University of Nebraska, Lincoln, Nebr.
7. *Potato Aphid Control Studies,* 1946-1949, *Woodstock, New Brunswick* J. B. ADAMS and R. A. KELLEY, Dominion Entomological Laboratory, Fredericton, N. B. Canada,

Wednesday Afternoon, December 7, Hotel Phillips (see bulletin board for room number) 1:30 P. M.

J. W. SCANNELL, *Presiding*

1. *Potato Insect Control and Tuber Yield in North Dakota* R. L. POST, R. W. McCALLEY and J. A. MUNRO, North Dakota Agricultural Experiment Station and State Seed Department, Fargo, N. D.
2. *New Insecticides for Wireworm Control* A. C. DAVIS and W. A. RAWLINS, Cornell University, Ithaca, N. Y.
3. *Flavor in Potatoes as Influenced by Organic Insecticides* W. A. MACLINN, J. P. REED, B. B. PEPPER and J. C. CAMPBELL, Rutgers University, New Brunswick, N. J.
4. *Performance of Potato Varieties in Pennsylvania in* 1949 O. D. BURKE and W. R. MILLS, Pennsylvania State College, State College, Pa.

5. *Procedure for the Introduction of New Varieties of Potatoes in Canada* N. M. PARKS, Division of Horticulture, Experiment Farm Service, Ottawa, Canada.
6. *Effect of Water Submersion on the Seed Value of Potato Tubers* E. V. HARDENBURG, Cornell University, Ithaca, N. Y.
7. *A Field Test of Plastic Electrodes to Determine the Need for Irrigation* A. J. PRATT and JOHN LAMB, JR., Cornell University and U. S. D. A. Soil Conservation Service, Ithaca, N. Y.

Thursday Morning, December 8, Hotel Phillips (see bulletin board for room number) 9:00 A. M.

O. D. BURKE, *Presiding*

Business Meeting
 Report of Secretary
 Report of Treasurer
 Report of Editor, American Potato Journal
 Committee Reports
 New Business
 Election of Officers

1. *Effect of Field and Storage Application of Sprout Inhibitors on Potato Tubers* E. R. MARSHALL and ORA SMITH, Cornell University, Ithaca, N. Y.
2. *Observations on Vascular Discoloration in Potatoes as a Result of Vine Destruction* M. W. MEADOWS and ORA SMITH, Cornell University, Ithaca, N. Y.
3. *The Use of Sulfur in Controlling Potato Scab in Iowa Peat Soils* W. J. HOOKER, Iowa State College, Ames, Iowa
4. *A Technique for Observing Tuber Formation and Scab Development in Potatoes* W. J. HOOKER, Iowa State College, Ames, Iowa.

Thursday Afternoon, December 8, Hotel President or Hotel Phillips (see bulletin board for room number) 1:30 P. M.

Joint Session, International Crop Improvement Association and Potato Association of America

H. M. DARLING, *Presiding*

See Certification Problems

Thursday Evening, December 8, Hotel Phillips (see bulletin board for room number) 7:30 P. M.

O. D. BURKE, *Presiding*

Smoker, social hour, movies, etc.
Report of Committee on Visual Education
GORDON A. BRANDES, *Chairman*

Friday Morning, December 9, Hotel Phillips (see bulletin board for room number) 9:00 A. M.

ARTHUR HAWKINS, *Presiding*

1. *Composition and Utilization of Potato Flour* R. H. TREADWAY and C. O. WILLITS, Eastern Regional Research Laboratory, U. S. D. A., Philadelphia, Pa.
2. *Chipping Quality of Several Varieties of Potatoes After Storage* J. S. COBB, Pennsylvania State College, State College, Pa.
3. *The Yield and Quality of Potato Varieties as Influenced by Irrigation, Date of Planting and Straw Mulch* A. J. PRATT and JOHN LAMB, JR., Cornell University and U. S. D. A. Soil Conservation Service, Ithaca, N. Y.
4. *Response of Potatoes to Sidedress Applications of Nitrogen Fertilizer in Connecticut in* 1949 ARTHUR HAWKINS, University of Connecticut, Storrs, Conn.
5. *Relation of Chemical Weed Control in Potatoes to Other Production Factors* ORA SMITH, M. W. MEADOWS and E. R. MARSHALL, Cornell University, Ithaca, N. Y.
6. *Chemical Weed Control in Potatoes* ORA SMITH, E. R. MARSHALL and M. W. MEADOWS, Cornell University, Ithaca, N. Y.
7. *Weed Control in Potatoes by Cultivation, Flame and Various Chemicals* SOLOMON COOK, Cornell University, Ithaca, N. Y.

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RELATION OF POTATO VARIETIES TO INCIDENCE OF PHYSIOLOGICAL INTERNAL TUBER NECROSIS

R. H. LARSON AND A. R. ALBERT

University of Wisconsin, Madison, Wis.

(Accepted for publication, Nov. 22, 1949

Field studies of varietal differences in incidence of non-parasitic internal tuber necrosis in the late potato crop, conducted at the Hancock Station, Waushara County, Wisconsin on Plainfield sand during 1938 to 1943, inclusive have been reported (3, 4, 5). The present paper is a report of additional field investigations also carried out at Hancock which have been underway since 1944. Older standard varieties were included in the field tests, in addition to the more recently introduced varieties, because of their known reaction to internal necrosis and adaptability to Central Wisconsin growing conditions. The incidence of internal necrosis (5, 8) was determined directly after harvest in four replicates of each variety.

Over a period of years considerable variation in relative susceptibility of potato varieties to internal necrosis has been observed. However, a comparative index (5-year average) for the varieties under test and a tentative classification of varieties are given in table 1.

TABLE I.—*Reaction of American potato varieties to internal necrosis.*

Variety	Internal Necrosis Index					Mean Necrotic Index
	1945	1946	1947	1948	1949	
Waseca	—	—	—	—	0	0[1]
Setapa	—	—	—	—	0	0[1]
Placid	0	0	0	0	0	0
Desota	0	0	0	0	0	0
Marygold	0	0	0	0	0	0
Triumph[2]	0	0	0	0	0	0
Kasota	6	0	1	0	7	2.8
LaSalle	2	4	3	3	0	2.4
Hebron	3	4	3	6	4	4.0
Virgil	8	5	4	3	1	4.2
Red Warba	16	0	4	0	2	4.4
Kennebec	—	—	—	—	5	5.0[1]
Empire	6	7	9	6	3	6.2
Teton	7	6	9	5	16	8.6
Mohawk	12	14	11	5	6	9.6
Pontiac	17	11	12	10	5	11.0
Menominee	33	8	8	5	10	12.8
Earliest of All	21	13	17	12	7	14.0
Erie	45	17	3	4	4	14.6
Gold Coin	17	27	21	7	5	15.4
Pennigan	42	11	11	10	9	16.6
McClure	44	21	8	3	9	17.0
Essex	16	21	19	24	6	17.2
Ontario	19	25	19	14	27	20.8
Hindenburg	31	26	19	23	16	23.0
Patomac	43	15	30	24	10	24.4
Pawnee	63	39	16	15	24	31.4
Russet Rural[1] [2]	56	31	28	23	21	31.8
Katahdin[2]	57	23	44	21	19	32.8

[1] — One year test
[2] — 6 year mean necrotic index—1938 to 1943 inclusive

Triumph	0
Russet Rural	40.5
Katahdin	39.5

Differences in the incidence of internal necrosis are apparent when the indices are compared. Triumph, Waseca, Setapa, Placid, Desota and Marygold have been entirely free of internal necrosis. Kasota, LaSalle, Hebron, Virgil, Red Warba, Kennebec, Empire, Teton and Pontiac were affected very much less than Menominee, Earliest of All, Erie and Gold Coin. An intermediate degree of internal necrosis was shown by Pennigan, McClure, and Essex. The most susceptible varieties under test were, in order of increasing susceptibility, Ontario, Hin-

TABLE 1.—*Insect and early blight control on potato spray plots, Lake City Experiment Station, 1948.*

Material and Dosage	Insect Control Percentage					Early Blight Per Cent Defolia-tion	Yield
	Potato Leaf Hopper	Six-Spotted Leaf Hopper	Spittle Bug	Aphids	Potato Flea Beetle		U. S. No. 1 Bus. Per Acre
1. (1) 629 + DDT (3 - 1½ - 100)	87	61	41	49	99	75	356.5
2. Yel. - cuprocide + Parathion (1½ - 1 - 100)	69	64	11	100	99	57	249.7
3. (2) 629 + 308 + DDT (3 - 3 - 1½ - 100)	72	67	31	42	99	75	305.4
4. Yel. Cuprocide + Parathion (1½ - 1 - 100)	25	70	0	100	99	50	253.3
5. Zerlate + CM150 (DDT) (2 - 2 - 100)	89	61	43	25	99	58	382.1
6. TBC + CM152 (DDT) (4 - 2 - 100)	77	70	70	64	100	65	282.8
7. Cu-Zn chromate + DDT (2 - 1½ - 100)	64	85	15	48	100	41	280.6
8. (3) Cu. 8 Quinol. + DDT (1 - 1½ - 100)	55	58	22	54	100	65	285.9
9. Dithane. D-14 + Shell 25 em. (2 qts. - 1Zn ½ Lime - 1 qt. - 100)	64	54	32	74	100	55	281.3
10. Dithane D-14 + Shell DDT (same as above + 2 lbs. DDT - 100)	68	42	33	57	99	50	342.9
11. Zerlate + D25 (25 per cent DDT) (2 - 1 qt. - 100)	66	70	18	62	100	48	314.6
12. Zerlate + 50 W DDT (2 - 2 - 100)	79	82	56	57	99	58	323.4
13. DDT alone (1½ - 100)	66	64	46	64	99	83	304.9
14. COCS + Dethyl (25 per cent em.) (3½ - 1 qt. - 100)	68	61	35	53	98	83	278.6

Table I—(Continued)

Material and Dosage	Insect Control Percentage					Early Blight Per Cent Defoliation	Yield
	Potato Leaf Hopper	Six-Spotted Leaf Hopper	Spittle Bug	Aphids	Potato Flea Beetle		U. S. No. 1 Bus. Per Acre
15. Z-78 + DDT (2 - 1½ - 100)	70	79	26	40	100	80	314.2
16. Parzate + DDT (2 - 1½ - 100)	72	88	39	62	99	60	342.4
17. Bord + DDT (8 - 4 - 1½ - 100)	77	54	52	48	99	67	277.2
18. TBC + 1154 (25 per cent DDT (em.) 4 - 1 qt. - 100)	55	67	7	65	99	61	278.8
19. (4) C & H micro. Cu + DDT (2 - 1½ - 100)	83	67	61	55	100	73	316.8
20. (4) C & H reg. Cu + DDT (2 - 1½ - 100)	77	88	30	24	99	62	286.3
21. (5) Cuprous oxide + DDT (2 - 1½ - 100)	66	58	50	12	99	58	295.1
22. TBC + 1155 (DDT 22½ per cent + chlordane 2½ per cent) 4 - 1 qt. - 100)	83	64	11	79	100	77	266.2

Difference in yield necessary for significance 67.1 bu. at 5 per cent; 88.1 bu. at 1 per cent level.

(1) Zn - nitrodithioacetate.
(2) Cu - nitrodithioacetate.
(3) Cu - 8 - quinolinolate.
(4) Calumet and Hecla (Cuprous and Cupric oxide).
(5) H. H. Robertson Co. (Cuprous oxide).

TABLE 2.—*Occurrence of internal tuber necrosis in the Ontario variety in Wisconsin*—1949

Location and Lot		Soil Type	Per cent Clean and Slight	Per cent Moderate and Severe	Tubers Examined				Internal Necrosis Index
					Clean	Slight	Moderate	Severe	
Three Lakes	—#1	Sandy loam	76.2	23.8	92	49	26	18	28
(Northern Wisconsin)	—#2	"	75.5	24.5	82	35	24	14	27
	—#3	"	79.3	20.7	79	32	16	13	25
	—#4	"	67.9	32.1	81	27	22	29	33
	—#5	"	65.0	35.0	71	15	18	19	29
	—#6	"	72.8	27.2	97	29	21	26	29
		Average	72.8	27.2					28.5
Antigo	—#1	Silt loam	76.3	23.7		58	26	8	31
(North Central Wis.)	—#2	"	75.8	24.2	51	61	24	14	32
		Average	76.05	23.95	58				31.5
Plainfield	—#1	Muck	84.0	16.0		27	9	7	22
(Central Wisconsin)	—#2	"	82.7	17.3	57	20	10	8	21
		Average	83.4	16.6	66				21.5
Racine	—#1	Silt loam	72.4	27.6		34	26	21	29
(South Eastern Wis.)	—#2	Silt loam	73.4	26.6	82	29	21	17	30
		Average	72.9	27.1	76				29.5

denburg, Patomac, Pawnee, Russet Rural and Katahdin. Two varieties, Ontario and Pawnee were outstanding in their susceptibility, exhibiting in many cases, a very severe irregular blotch type of internal necrotic discoloration in addition to diffused necrosis.

During the 1949 season, plantings of Ontario over the entire state in all types of soils, showed a very high incidence of internal necrosis of the severe type. The locations, soil types, internal necrosis index, as well as percentage of tubers showing little or no necrosis and those exhibiting moderate and severe internal discoloration in the Ontario lots examined are given in table 2.

The occurrence of internal necrotic discoloration in Ontario produced on muck soils in 1949 is the first record of physiological tuber necrosis on this type of soil in Wisconsin. Other potato varieties (Pontiac, Katahdin, Chippewa and Cobbler) grown adjacent to Ontario on the mucks when examined showed no tubers affected. The Ontario is the only variety which exhibited extreme susceptibility to internal necrosis over a wide range of growing conditions and on various soil types during the 1949 growing season.

The severe losses sustained during certain seasons in the late crop in Central Wisconsin caused by internal tuber necrssrs and in the Ontario variety throughout 'the entire state this past season, emphasizes the importance of continued field trials in search of adaptable, necrosis-resistant varieties and indicates the great need of potato improvement in this direction.

In addition to the Americon potato varieties under test during 1944 through 1949, 13 British varieties were also tested. Differences in varietal susceptibility to internal tuber necrosis in the British varieties were as great as those found in American varieties. Differences in the incidence of internal tuber necrosis in British varieties as expressed by the necrotc index are shown in table 3. King Edward and Up to Date, have consistently shown a low necrotic index, while Arran Scott, Great Scot Epicure, Arran Consul and Majestic have been the most susceptible over a period of years under Central Wisconsin conditions. Differences in the incidence of internal rust spot in British varieties have been reported from England (1, 2, 6) and Holland (7).

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TABLE 3.—SUSCEPTIBILITY OF BRITISH POTATO VARIETIES TO INTERNAL NECROSIS

Variety	Internal Necrosis Index						Mean Necrotic Index[1]
	1944	1945	1946	1947	1948	1949	
King Edward	9	3	3	4	3	1	3.8
Up-to-Date	3	9	1	3	7	4	4.5
Arran Cairn	24	57	11	22	11	7	17.0
President	27	29	12	17	10	9	17.3
Ballydoon	21	31	9	16	12	17	17.7
Kerr's Pink	16	14	22	23	14	17	17.7
Arran Banner	16	28	21	22	13	9	18.1
British Queen	22	38	10	17	15	12	19.0
Arran Victory	17	46	12	13	20	11	19.8
Arran Scout	40	23	38	13	21	11	24.3
Great Scot	34	54	14	32	20	21	29.1
Epicure	42	57	22	27	37	19	34.0
Arran Consul	46	67	27	49	21	31	40.1
Majestic	46	55	57	55	28	27	44.7

[1] — 6 year mean index

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THE RINGSPOT TYPE OF POTATO VIRUS X[1]

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A severe disease of potato (*Solanum tuberosum,* L.) due to infection with the ringspot type of virus X has been observed for the past several years in the Wisconsin seed fields of Chippewa, Sebago, Red Warba, Pontiac and Katahdin (3, 4, 5). Infected plants are characterized by a foliar mottle and necrosis or even lethal top necrosis. Isolations from such plants to *Nicotiana rustica* L. and *N. tabacum* L. var. Havana 38 at 24°C. resulted in only severe ringspot symptoms. A clear concentrically-lined ring was always the dominant lesion type. However, two others were also isolated from some of these plants, one a ring type with a necrotic border and the other a necrotic-spot or local-lesion type. By means of single-lesion isolations, apparently pure cultures of the above three types were obtained. All three caused characteristic symptoms on *N. rustica, N. tabacum and N. glutinosa* L. at 24°C., but only necrotic-spot-type local lesions on the inoculated leaves of these hosts at 16°C. The three types produced spot-necrosis of tobacco when combined with the common strain of potato virus Y and streak of tomato (*Lycopersicum esculentum* Mill.) when mixed with tobacco virus I.

Older American potato varieties, such as Triumph, Cobbler, Green Mountain, Russet Burbank and Russet Rural are universally infected with a latent mild mottle type of virus X. The ringspot strain of virus X was found to accompany the mottle in all symptomless plants of the above varieties tested, though there was considerable variation in relative amount of ringspot present and also in the intensity of mottle in different varieties and, to a lesser extent, between plants within a variety. Apparently pure cultures of ringspot were separated from the attendant mottle in apparently healthy potatoes by single-lesion isolations from inoculated tobacco. The necrotic-ring and necrotic-spot types were also isolated from symptomless plants of the above varieties.

Ringspot isolates derived from severely diseased field potatoes, from apparently healthy greenhouse-grown potatoes and four ringspot cultures from other laboratories were used as inoculum in a series of

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potato inoculations. The latter cultures were the "virulent latent virus" from Early Rose (2), "severe X" from British Queen (1), a severe strain isolated from Arran Peak (6) and a ringspot type isolated from naturally infected pepper (*Capsicum annuum* L.) plants supplied by H. H. McKinney, U.S.D.A., Beltsville, Maryland. All isolates caused local lesions followed by severe systemic symptoms when inoculated to X-free plants of certain recently introduced potato varieties at 16°C. The response of Red Warba and Pontiac was very necrotic and inoculated plants were usually killed, whereas Ontario showed mainly mottle and crinkle with moderate necrotic flecking of the foliage. The isolates originally obtained from symptomless plants of older varieties were fully as virulent on X-free potatoes as those derived from potatoes showing severe symptoms. The original sap mixture of mottle and ringspot found in symptomles potatoes (Irish Cobbler, Triumph and Russet Rural) caused definite but less severe symptoms than pure ringspot on inoculation to X-free potatoes and the complex was recovered unchanged from the first as well as second generation plants.

Tolerance to ageing, dilution and heat was similar for the various ringspot isolates studied. A mottle type of virus X from Russet Rural completely protected *Datura stramonium* L. var. *tatula* against infection with any of the isolates tested. However, the isolate originally derived from pepper lacked an antigenic fraction possessed by 10 isolated from potato. A clear-ring type isolate from Red Warba infected all members of the Solanaceae tested, 4 members of the Labiatae, 10 species of Scrophulariaceae and 4 species of Amaranthaceae as shown in table 1.

TABLE 1.—*Symptoms produced on young non-solanaceous plants when mechanically inoculated with a clear-ring type isolate of potato virus X at a constant temperature of 24°C.*

LABIATE (Mint)

Host	Symptoms Resulting from Inoculation
Salvia lancaefolia, Poir. (flowering sage)	Local: Numerous dark flecks, changing to local necrotic lesions in 5 days; premature leaf cast. Systemic: Slight chlorotic mottle and irregular necrotic lesions.
Nepeta cataria, L. (catnip)	Local: Few, chlorotic lesions; no necrosis. Not systemic.
Ocimum basillicum, L. (sweet basil)	Local: Clear ring lesions; no necrosis. Systemic: Few, clear ring lesions and mild chlorotic mottle; no necrosis.
Satureja hortensis, L. (summer savory)	Local: Necrotic flecks enlarging to form necrotic lesions; premature leaf cast. Systemic: Slight chlorotic mottle and moderate necrosis; some necrotic stem streaking; slight stunting.

SCROPHULARIACEAE (Figwort)

Veronica orchidea, Crantz.	Local: Irregular, scattered chlorotic lesions in 10 to 12 days; no necrosis. Not systemic.
V. serpyllifolia, L. (thyme leaved)	Local and systemic: as above.
V. teucrium, L. (saw-leaved)	Local and systemic: as above.
V. longifolia, L.	Local and systemic: as above.
Linaria cymbalaria, (L.) Mill (Kenilworth Ivy)	Local: Faint yellow halo-type lesions; no necrosis. Systemic: Mild interveinal chlorosis; no necrosis.
L. bipartita, Willd.	Local and systemic: no sysmptoms, carried.
L. maroccana, Hook.	Local and systemic: no symptoms, carried.
L. vulgaris, Hill. (toad flax)	Local and systemic: no symptoms, carried.
Digitalis lanata, Ehrh. (grecian foxglove)	Local: Necrotic flecks enlarging to reddish-brown irregular areas and ring lesions; more severe at 16°C. Not systemic.
D. ambigua, Murr. (yellow foxglove)	Local: Few, faint halo-type lesions developing necrotic borders; more severe at 16°C. Not systemic.

AMARANTHACEAE (Amaranth)

Amaranthus oaudatus L. (tassel flower)	Local: Conspicuous small brick-red lesions in 3 to 4 days, on enlarging, outer edge becomes dark; premature leaf abscission. Not systemic.
A. hybridus L. (green amaranth)	Local: Conspicuous small necrotic lesions in 3 days, enlarging to involve the entire leaf; premature leaf abscission. Not systemic.
A. retroflexus L. (redroot pigweed)	Local and systemic: as above.
A. tricolor L. var. aurora	Local: Conspicuous small brick-red lesions in 3 days, becoming pigmented, followed by diffuse chlorotic mottle and general necrosis, premature leaf abscission. Not systemic.

A clear-ring type isolate was transmitted by dodder (*Cuscuta campestris* Yunker) but not by the potato flea beetle (*Epitrix cucumeris* Harris).

Field inoculations were made to 41 potato varieties and severe symptoms developed in inoculated plants of some of the more recently introduced varieties. Symptoms of field inoculated plants in the second generation were also severe, but in the third year of infection, symptoms were definitely less marked and the virus was attenuated.

Field and greenhouse inoculations showed that all plants of older American potato varieties tested were carrying a latent mild type of virus X and hence did not develop symptoms on inoculation. There was no evidence of entry of the ringspot virus. Greenhouse inoculations were made to Ontario, Chippewa, Sebago, Pontiac and Katahdin and tests for the presence of virus X were made of plants from the same tubers from which inoculated plants were grown. The plants which showed no symptoms on inoculation were found to be previously infected with a mild type of virus X as evidenced by serological precipitin tests and cross-protection reactions on *D. stramonium.* The plants which developed necrotic local lesions and severe systemic symptoms on inoculation were originally free from virus X. Pontiac and Katahdin showed, in addition to chlorotic mottle and crinkle, severe systemic necrosis and the plants were usually killed. Ontario, Chippewa and Sebago, on the other hand, showed systemic mottle with much less necrosis. Some plants of Chippewa and Sebago gave a partial response to inoculation. though previous infection with virus X was demonstrated by precipitin and cross-protection tests. It was shown that this incomplete protection was due to a delayed movement of the latent virus from the tuber into the aerial parts of the plant in sufficient concentration to prevent entry of the ringspot virus. Delayed movement of the virus in plants of this type tends to make tests for the presence of virus X unreliable when based on sprouts or even young plants.

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COSTS, YIELDS, AND PROFIT MARGINS IN POTATO PRODUCTION

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A phase of potato production which is often neglected in the more technical journals dealing with the subject is that having to do with production costs and the yield-profit relationship. An intimate knowledge of this subject, of course, comes only with the experience of raising and harvesting the crop for the commercial market, and most growers who are in the business in a commercial way perhaps assume that all are familiar with it as a matter of course. Calculation of the selling price necessary to break even is a basic consideration in the raising of vegetable crops, and will be of increasing importance to the potato grower in the years which lie ahead.

It is not difficult for the grower to calculate within fairly close limits the cost of producing a given quantity of potatoes at any yield level, taking into consideration the factors involved in his particular operation. It is important to bear in mind, in this connection that there are certain pre-harvest costs (seed, fertilizer, etc.) which can be calculated on a per acre basis and which do not vary with the yield obtained. There are other costs, mainly concerned in the harvesting of the crop, which are progressive in nature and must be calculated on a per bushel or per hundred-weight basis. It is the combination of these two costs at any given yield level which makes up the total cost of production.

To illustrate how these two costs may be plotted graphically to arrive at the overall cost of production, we have chosen the 1948 figures from the operation of our own farm on which we raised approximately 100 acres of potatoes. In our opinion, it is doubtful if the individual cost figures will change significantly in the immediate future. The overall costs may vary considerably, however, between different growers, depending on the methods of production and marketing that are used in each individual case. The point is that any grower can calculate his cost of production by plotting the combination of his pre-harvest and harvest costs at various yield levels. It is then possible, after determining the yield per acre, to determine the break-even point, or the selling price necessary to just cover the cost of raising the crop. In the same

manner, if the selling price is known, it is posible to calculate the yield necessary to reach the break-even point.

These facts are illustrated in the following diagrams, in which the following costs have been used as a basis for calculation:

Pre-Harvest Costs/Acre	
Seed	$50.00
Fertilizer	45.00
Plowing	2.50
Planting	2.75
Seed Cutting	1.50
Spraying	27.00
Cultivation	4.50
Irrigation	6.00
Cover Crop	10.25
Digging	3.50
Depreciation	30.00
Taxes	10.00
Insurance	2.20
Maintenance	10.00
Compensation	1.25
Electric and Telephone	1.00
Total	$207.45

Harvest Costs/Bu. Unit	
Picking	$0.07
Grading	.05
Hauling (field)	.015
Sacks	.12
Delivery	.18
Commission	.03
Total	$0.465

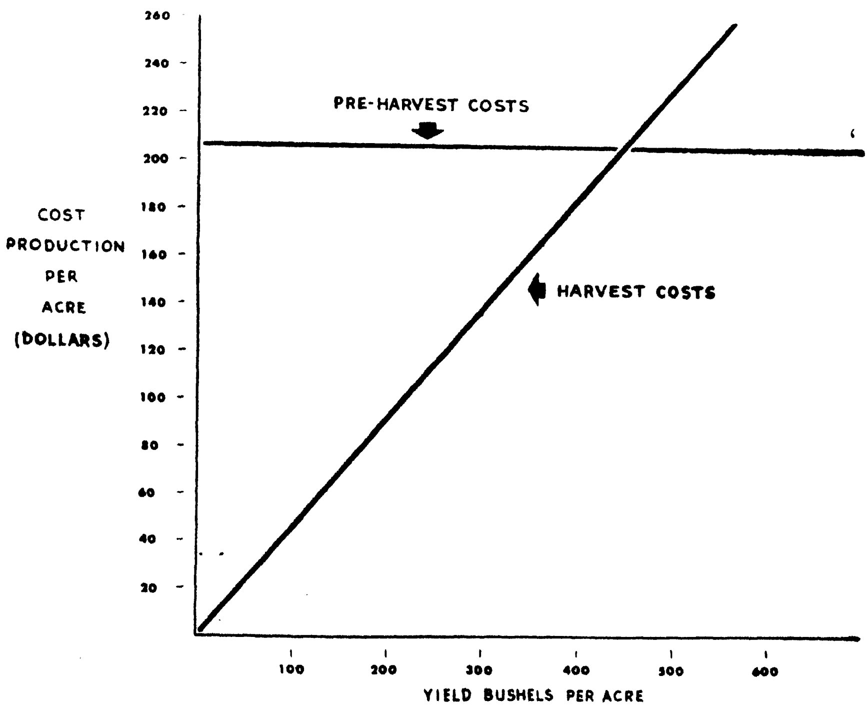

FIG 1

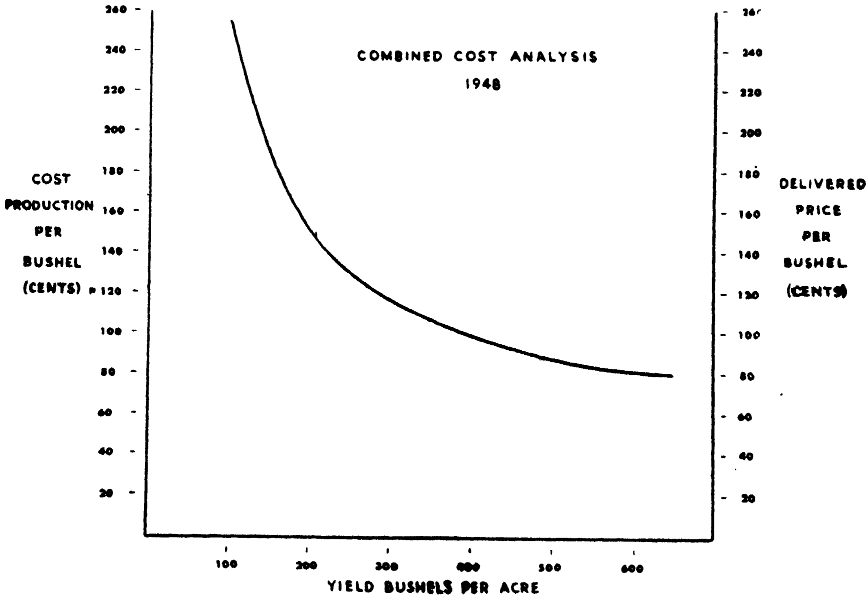

FIG 2

Figure 1. shows the pre-harvest costs plotted at a constant level when calculated on a per acre basis and harvest costs increasing with the yield in a regular manner. In figure 2. these two costs are combined on a cost per bushel basis and plotted against yield per acre. For example, at the 200 bushel per acre level, the pre-harvest costs would be $207.45/200 or $1.04 per bushel. The harvest costs would be constant for each bushel of potatoes produced and amount to $0.465 per bushel. The sum of these two costs is $1.50 per bushel, which represents the total cost of production at the 200 bushel per acre level. The same type of calculation is carried out at a series of yield levels to obtain the curve in figure 2. Once this curve is established for any individual operation it provides a convenient means of calculating profit margins at varying yield levels.

It is of interest to point out that the curve in figure 2. gradually approaches a straight line as the yield increases and the cost of production per bushel decreases. The reason for this, of course, is that while the harvest costs remain constant on a per bushel basis with increasing yields, the pre-harvest costs diminish regularly as they are divided over an increasing number of bushels. It is incorrect to assume that it requires a certain yield to meet expenses and that everything over that is profit. As these figures show, the margin of profit does increase as pre-harvest cost per bushel decreases with increasing yield, but this profit increase is not indefinite.

POTATO STORAGE AND QUALITY OF FRENCH FRIES
I. KATAHDIN*

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Potatoes selected for study as a part of an investigation of the effects of cooking on the vitamin and mineral content of 23 foods (3) were found to contain excessive amounts of reducing sugars when obtained on the Washington, D. C. market during January, 1946. These potatoes apparently had been exposed to low temperatures (2, 5, 7, 8). French fries made from them were generally poor in edible quality, confirming the Bureau's previous findings (8).

In order to improve the quality of french fries if possible, it was deemed advisable to lower the content of reducing sugars by conditioning the potatoes (2, 7, 8). A survey of available information revealed that there were no recorded observations concerning (a) the period of conditioning required at room temperature, 70 to 75°F. (21 to 24°C.), for desugaring to an acceptable level, potatoes which had been stored below 40°F. (4°C.); (b) the edible quality of french fries made from potatoes which had been appreciably desugared; (c) the influence of degree of mealiness of potatoes on rate of desugaring, and on edible quality of french fries prepared at intervals during conditioning periods. Therefore, to help provide the information needed, studies were conducted with "oversweet" potatoes of different varieties and mealiness, conditioned for varying periods before french frying. In this paper, the first of a series of three, results on Katahdin potatoes are reported.

EXPERIMENTAL PROCEDURE

Katahdin potatoes were furnished by the Bureau of Plant Industry, Soils, and Agricultural Engineering from surplus stock. They were harvested at Presque Isle, Maine, in late September, 1945. After a few days the potatoes were shipped to the Plant Industry Station, Belts-

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ville, Maryland, where they were placed in a potato house on the 5th of October and held in typical winter farm storage, at 35 to 40°F. (1.5 to 4°C.).

On February 6, 1946, after 124 days in the potato house, a portion of potatoes was transferred to our laboratories. The potatoes were washed, wiped dry with towels, and sorted out into lots according to degree of mealiness by Smith's salt-density method (6). To carry out this procedure two salt solutions were prepared, the one of specific gravity 1.078 (22 ounces common salt in 11½ pints water), the other of specific gravity 1.088 (24⅔ ounces salt in 11 pints water), and the potatoes were placed in these solutions to determine their degree of mealiness: Potatoes that floated in the solution of specific gravity 1.078 were separated as non-mealy, those that sank in this solution but floated in the solution of specific gravity 1.088, slightly-to-medium mealy, and those than sank in the latter solution, mealy.

After the potatoes were identified as to their degree of mealiness, they were conditioned at 70 to 75°F. (21 to 24°C.) in a dark room, equipped with fans to circulate the air, for the following lengths of time: 7, 19, 28, 51, 72, 84, or 91 days. A second portion of the potatoes, held in the potato house for 158 days, was separated into lots according to degree of mealiness by the above method, and conditioned for 1 day. After 164 days in the potato house, a third portion of the potatoes, separated into lots according to degree of mealiness by the above method, was conditioned for 35, 43, 56, and 63 days.

At the end of each period of conditioning, potatoes of one or more degrees of mealiness, were withdrawn in quantity required to provide 6 servings—approximately 750 gm. unpared (1, 3)—for measurement of their reducing sugar content and for french frying.

The picric acid coloration method was used for sugar determination (5). Samples were obtained by removing a cylindrical plug from each pared potato before it was cut into strips for frying. For each potato, the color produced by the test was matched as closely as possible to the colors reported for potatoes stored at 32, 36, 40, 50, or 60°F. (0, 2, 4, 10, and 15.5°C.), and the potato was classified accordingly into one of three groups as to its proximate content of reducing sugars. Potatoes producing coloration closest to that for potatoes stored at 32, 36, or 40°F. were classed as "excessive" in sugar; those producing coloration lighter than that for potatoes stored at 40°F. but darker than that for those stored at 50°F. were classed "moderate;" and those matching the 50°F. storage sample but darker than the 60°F.

Table 1.—*Yield of raw pared mealy, slightly-to-medium mealy, and non-mealy Katahdin potatoes, and of French fries, after potatoes were conditioned for different lengths of time at 70-75°F. (21-24°C.)*

Conditioning Period after Removal from Potato House	Mealy: Potatoes per Lot Cooked[1]	Mealy: Yield Raw Pared to Unpared	Mealy: Yield French Fries to Raw Pared	Slightly-to-medium-mealy: Potatoes per Lot Cooked[1]	Slightly-to-medium-mealy: Yield Raw Pared to Unpared	Slightly-to-medium-mealy: Yield French Fries to Raw Pared	Non-mealy: Potatoes per Lot Cooked[1]	Non-mealy: Yield Raw Pared to Unpared	Non-mealy: Yield Fries to Raw Pared
Days	Number	Per cent	Per cent	Number	Per cent	Per cent	Number	Per cent	Per cent
1	8	90.7	39.0	4	92.9	38.7	7	91.7	35.1
7	—	—	—	5	91.3	36.9	—	—	—
19	9	90.4	39.2	5	91.9	37.7	8	88.0	34.9
28	6	90.5	39.1	4	91.0	38.1	5	89.6	35.9
28	—	—	—	5	89.9	39.7	—	—	—
35	8	87.5	38.3	8	89.3	37.8	9	85.6	36.1
43	12	84.8	37.0	8	87.0	37.2	11	82.1	36.4
51	9	86.8	37.8	5	87.9	36.0	6	87.6	36.3
56	11	85.7	37.2	7	86.8	36.1	13	80.4	37.0
63	12	83.0	37.7	8	85.3	36.5	19	80.8	34.6
72[2]	17	80.2	39.9	8	82.8	38.8	6	84.1	36.2
84	—	—	—	8	84.3	38.2	8	80.7	37.6
91	—	—	—	—	—	—	9	78.0	38.3
Average	10	86.6	38.4	7	88.4	37.6	9	84.4	36.2

[1]Approximate weight, unpared, 750 gm.
[2]Non-mealy potatoes conditioned for 71 days.

were classed "slight" in sugar content. For each cooking sample, the percentage of tubers in each reducing sugar class was calculated.

The french fries were prepared by the standardized method (1, 3) developed in our laboratories, with the following modifications for mealy and slightly-to-medium mealy potatoes conditioned for 1, 19, and 28 days: The parfrying temperature was lowered from 195 to 190°C. (383 to 374°F.) and the final temperature from 210 to 202°C. (410 to 396°F.).

The quality of the french fries was judged subjectively for color, texture, flavor, degree of oiliness, and general acceptability (1). The color of representative fried strips was also matched to Maerz and Paul color charts (4).

Results and Discussion

In the Katahdin potatoes used in this study the salt-density test showed that slightly-to-medium mealy tubers predominated, and of the remainder there were more of the non-mealy than mealy tubers.

Per cooking sample the number of potatoes varied according to their size as is shown in table 1. As shown in the table, with longer conditioning and more small potatoes per sample, the yield of raw pared to unpared weight (including sprouts) decreased. The yield of french fries was apparently influenced by the degree of mealiness (table 1)—generally, the mealier the potato the greater was the yield of french fries.

One day after removal from potato house a majority of mealy and all slightly-to-medium mealy and non-mealy potatoes contained an "excessive" accumulation of reducing sugars as will be noted in table 2. As conditioning progressed to 72, 84, and 91 days for mealy, slightly-to-medium mealy and non-mealy potatoes, respectively, the excess of reducing sugars was decreased, but not entirely eliminated.

The rate of desugaring appeared to be influenced by the degree of mealiness of the potatoes as you will note in table 2. For example, the period of conditioning at which potatoes were not found in the "excessive" sugar class was 19, 35, and 51 days, respectively, for mealy, slightly-to-medium mealy, and non-mealy potatoes; non-mealy potatoes were found again in the "excessive" class at 56, 63, and 84 days. Similarly, the influence of degree of mealiness was shown by the period of conditioning at which a majority of potatoes was in the "slight" sugar class: 43 days for mealy; 63 days for slightly-to-medium mealy; and 91 days for non-mealy potatoes.

It should be noted that in any given period of conditioning, individual tubers in a cooking sample differed from each other in concentration of reducing sugars. Non-mealy potatoes were the most variable in this respect. For all three degrees of mealiness, differences among individual tubers may explain apparent inconsistencies in this trend toward lowering of the content of reducing sugars as conditioning progressed.

Color, or intensity of browning, of the french fries (table 2), appeared to be influenced mainly by the concentration of reducing sugars in the raw potatoes, a result in agreement with previous findings of the Bureau (8). In general, as the content of reducing sugars decreased during conditioning, the color of the french fries became correspondingly lighter, those made from the mealy potatoes progressing faster than those from the less mealy.

It is possible that factors other than reducing sugars affected the color of the fried potatoes, which may account for some of the results described—for example, certain slightly-to-medium mealy potatoes conditioned for 19 and 28 days, and non-mealy potatoes conditioned for 28, 56, and 84 days, although "excessive" in sugar content did not produce dark french fries.

Texture of french fries was significantly improved by progressive conditioning of the potatoes, with the degree of success depending on degree of mealiness. However, as shown by the descriptive terms in table 2, the french fries within a single cooking lot were frequently not homogeneous in texture. After conditioning for only one day, regardless of degree of mealiness, the potatoes produced, in the main, limp and soggy french fries. Conditioned for 43 to 72 days, mealy potatos produced crisp and mealy french fries; *i. e.,* of highly desirable texture. French fries made from slightly-to-medium mealy potatoes showed similar improvement in texture, but longer conditioning was required, 56, and 63 days, respectively; this quality was not maintained at 72 and 84 days, respectively. Non-mealy potatoes, although given the longest conditioning (91 days) did not produce french fries with texture equal to the best obtained from the mealier potatoes. Slight improvement in texture of french fries made from non-mealy potatoes was noted by some of the judges and described as a tendency toward crisping and flaking, reaching its peak at 71 days.

Degree of oiliness was associated with certain characteristics of texture, as, for example. limp and soggy french fries were usually considered by the judges excessively oily, whereas crisp and mealy

french fries were moderately to slightly oily. It is of interest to note with other varieties, where total fat content of the french fries was determined, that limp and soggy french fries contained more fat than crisp and mealy ones (3).

Flavors described as sweet and burned were noted by the judges here as well as in previous tests (8) of french fries made from potatoes with excessive accumulation of reducing sugars; bitterness was also noted in the present study. As progressive conditioning lowered the sugar content, the sweet and burned flavors disappeared, but bitterness persisted in many lots. There were, however, fewer reports of bitterness among french fries made from the mealy potatoes than from the less mealy.

General acceptability of french fries, using degree of mealiness of raw potatoes and periods of conditioning as criteria, was given highest ratings as follows: Mealy at 63 and 72 days—very good to excellent; slightly-to-medium mealy at 56 and 63 days—good to very good; non-mealy at 71 and 84 days—fair to good.

These studies have produced results of practical value since they showed that mealy and slightly-to-medium mealy Katahdin potatoes which contained excessive amounts of reducing sugars could be successfully utilized for french frying provided they were adequately conditioned. To accomplish this, from 56 to 72 days conditioning at 70 to 75°F. (21 to 24°C.) was required. It is worth noting that when the conditioning was inadequate the lowering of standard frying temperatures did not solve the problem of making good french fries from the oversweet mealy and slightly-to-medium mealy potatoes used in these studies. As an application of these findings, since the mealier potatoes "recovered" better than the non-mealy ones, it appears desirable to select mealy Katahdin potatoes in preference to non-mealy ones for storage at low temperatures and later use in the making of french fries.

Summary and Conclusions

Katahdin potatoes grown in Maine in 1945 and placed in storage in a potato house in Maryland during October of that year were withdrawn at intervals during February and March, 1946, sorted out into 3 lots according to degree of mealiness by a salt-density method, conditioned at 70 to 75° F. (21 to 24°C.) for periods varying from 1 to 91 days, tested for content of reducing sugars by the picric acid coloration method, and french fried. The yield and edible quality of the french fries were determined.

After conditioning for 1 day, potatoes were excessively high in reducing sugars and produced poor french fries. As the period of conditioning was increased, the content of reducing sugars decreased gradually but was not restored to normal. The mealier the potatoes, the more rapidly they desugared, and the higher the yield and the better the edible quality of the french fries. With adequate conditioning, mealy potatoes produced french fries which were rated very good to excellent, and slightly-to-medium mealy, good to very good. Non-mealy potatoes "recovered" less successfully and produced only fair to good french fries.

Results suggested that as a conservation measure for Katahdin potatoes which are to be stored at low temperature for later use in french frying, it appears desirable to store mealy rather than non-mealy tubers.

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SECTIONAL NOTES

Michigan

The movement of potatoes out of Michigan this fall is far below that of last year for the same period of time. It would appear that our

volume is slightly under that of last year; but with the reduced movement to date, it would mean that from now on, the balance of the season, Michigan will have to ship more cars and trucks than were shipped out after December 1st last year.

Certified Seed bin inspection is now completed. The volume is slightly above that of last year. There is a noticeable shift in varieties, mostly from Russet Rurals to Katahdins.

A new record of high yields was established this year. Michigan has a 500-bushel club which is based on five or more checks on five or more consecutives acres. High yield, which is an all-time state record, was made by Paul Damme of Cornell with a yield of 1034 bushels per acre. This was not just an accident, as yields of more than 800 bushels per acre have been previously recorded on Paul's farm.

There is a rather interesting story of this Vam Damme family. Jules the father, came to Delta County, Michiga nfrom Belgium after World War I, and the Van Damme farm was cleared after the lumber company had removed the timber. The family was raised on this farm; and as it was cleared up and the boys grew up, more land was acquired and more land cleared. Today the Van Dammes are operating four separate units consisting of several hundred acres each. The Michigan 500 bushel-club is fairly well represented by the Van Dammes—Paul, 1034 bushels per acre; Jules (the father), 705 bushels; Gerald, 654; and two other brothers operating as Van Damme Brothers, 643 bushels per acre.—H. A. Reiley.

Nebraska

Bin inspection of all Nebraska Certified seed potatoes was completed by the 15th of November. Our records indicate that the yields and quality of dry land certified seed are better than last year. Yields under irrigation were somewhat lower, but the quality was much better, because of less scab and less mechanical injury. In 1948, 7,497 acres were accepted for certification; and in 1949, 6,280 acres. This reduction may be accounted for by the reduced acreage entered in 1949. Rejections and withdrawals were approximately the same both years.

Despite the reduced acreage, the supply of U. S. No. 1 Bliss Triumph seed is 418,220 cwt. in 1949, or only slightly under 432,179 produced in 1948. Other states producing Bliss Triumph certified seed also have good crops. Consequently, the competition for seed sales in the southern states continues. It appears that a lot of certified seed will be sold as table stock again this year.

The November shipments of certified seed from Nebraska are considerably lighter than in 1948. The volume of table stock shipments is also lower. Market prices are not satisfactory, and the demand is lighter than usual. Western Nebraska shippers have been packing and washing part time only. The growers are dissatisfied with present market prices. A few are selling part of their crop, but most of them are keeping them in storage, hoping for a better price after the first of the year.

Last year very few of our growers took advantage of Government support, because they were able to market their potatoes at prices above support. Most of them are eligible for support again this year, and will probably take advantage of Government support prices if the market fails to improve after the 1st of January.—W. A. TRANK

NEW JERSEY

Potato growers in many areas as well as in New Jersey experienced the poorest growing season on record. As a result tuber quality was somewhat affected by the poor growing conditions. Yields, in general, and the Cobbler variety, in particular, were much lower than average. Many tubers sprouted in the ground long before the plants were mature which resulted in increased labor costs when they were graded. Many potatoes that were harvested during the latter part of September or later were affected with a rot very closely resembling leak, although the Pythium organism, causing leak was not isolated from any of the diseased specimens examined. Potatoes that were placed in storage sprouted prematurely or broke down with soft rot in many instances. Because of these factors very few potatoes are now in storage in this state, probably less than in many years. Our growers are hoping for a more normal season next year.

Our seed growers experienced a little better growing season and a total of 30,900 bushels of seed was certified. Sixty-two per cent of the production was of the Katahdin variety; 22 per cent Chippewa; 5 per cent Red Skin; 4 per cent Sequoia, and the balance of the production was comprised of Pawnee, Cobbler and Mohawk.

NEW YORK

There were 4,200 acres of potatoes which passed inspection this year. This is 11 per cent higher than the amount certified last year. The Katahdin variety accounted for more than one-half the total acreage.

The yields per acre have turned out fairly well; far better than

expected earlier in the season. Our growers are complaining of unevenly-sized tubers, the majority of the complaints being against oversized tubers which developed during the humid period in September.

All samples from certified fields have been sent to Florida and planted there for winter testing.—F. JOHN MACABEE

SOUTH DAKOTA

Dry weather and insects reduced the potato crop in South Dakota far below normal. Certified growers harvested good yields in most cases, because of the use of good seed and a well planned spraying program. A total of 5229 acres of potatoes was entered for certification in 1949. Three hundred and thirty six acres were rejected at the time of the first inspection and 266 acres were withdrawn. Then 995 acres were rejected on the second inspection and 776 acres were withdrawn, before the second inspection. Our records show a production of approximately 350,000 bushels of stock eligible for certification. Most of these are in storage and will be graded after the 1st of January.

We have the same Marketing Agreement order in effect this season as we had last year, except that U. S. No. 1 "B's" may be sold. Shipments of potatoes grading below 80 per cent No. 1 quality are restricted. The C. C. C. buys the No. 2 grade and to date about 35,000 bushels have been purchased, or nearly 17 per cent of the shipment. Most of these have gone for livestock feed within the State, but lately the school lunch program and charitable institutions have used a few cars—JOHN NOONAN.

VERMONT

The yields of commercial potato fields in Vermont were heavy and the quality of stoc kput into storage was good. Little late blight injury was reported. The weather was good throughout the harvesting period and the crop went into storage in excellent condition.

Indicative of the high yields of the season were official computations made by County Agents for the "400 Bushel Club". Since membership in the "400 Bushel Club" is confined to certified seed growers, its possible membership is rather limited. Of the 12 who bothered to have check-ups made and were found to qualify, 9 would have made a "600-Bushel Club" and 2 would have passed a "700-Bushel" requirement Those men who ranked high were: Fred W. Peaslee of Guildhall, first, with 760.3 Bus/A Green Mountains; Rudolph Danforth, Tunbridge, second, with 701.5 Bus/A Green Mountains; Joseph Brow, Albany, third, with 689.4 Bus/A Katahdins; and C. J. Batten, E. Hardwick,

fourth, 644 Bus/A Katahdins.

The State's total acreage of certified seed was 573.

Except for one grower who has made some substantial sales in New Jersey, there has been little activity in the seed market.

Pecks are being put up at some of the warehouses, but many potatoes are being offered to the government on the support buying program.

Of the estimated total harvest of Vermont potatoes — 1,184,000 bushels — a good guess is that nearly a million are still in storage. A major part of these are in very small lots, many of which may be consumed in the homes where they were grown.—HAROLD L. BAILEY

DOMINION OF CANADA

With exhibits from every Province in Canada, except Newfoundland, and several from Minnesota and Michigan in the United States, the 1949 Potato Show at the Royal Winter Fair, Toronto, Ontario, Canada, was an outstanding success. It attracted a total of 368 excellent exhibits, each consisting either of 30 selected tubers, or one bushel lots. All were displayed on specially designed trays, arranged on slightly tilted tables so that each tuber could be readily seen, and the mass attracted wide-spread attention. First and second prize winners in various seed classes were:

White, Oval (Irish Cobbler etc.)

1. Gabriel Kolometz, Dunning, Ontario
2. G. MacMillan, Cornwall, P.E.I.

White, Oval, Intermediate (Chippewa, "etc.")

1. Theodore Despatie, Hanmer, Ontario
2. D. C. Hackett, Cochrane, Ontario

White, Oval, Late (Katahdin etc.)

1. Arthur H. Budarick Palmer Rapids, Ontario
2. John Henderson, Renfrew, Ontario

White, Oval, Extra Late (Sebago etc.)

1. Milton Weatherilt & Sons, Bethany, Ontario
2. Frank McManus, Grand Falls, N. B.

White, Intermediate Long (Green Mountain etc.)

1. Frank Rick, Trout Creek, Ontario
2. Theodale Michaud, St. Paul de la Croix, Quebec

Netted or Russet (Netted Gem etc.)

1. Ross Bros., Pemberton, B. C.
2. J. Decker, Pemberton, B. C.

Rose or Red (Warba etc.)

1. Arthur H. Budarick, Parmer Rapids Ontario
2. J. Pawson, Estevan Sask.

Any Other Variety

1. Gerald Trueman, Amherst, N. S. on Pawnee
2. Vic. Guichon, Ladner, B. C. on White Rose.

The World's Championship award made available by the American Potash Institute Inc., Hamilton, Ontario, was won by Theodore Despatie, Hanmer, Ontario, Sudbury District on his entry of Foundation A Chippewa.

Reserve Championship went to Ross Bros., Pemberton, B. C., on their entry of Netted Gem.

The Gray-Snyder Special for Chmpionship in the table stock classes was awarded to Arthur H. Budarick, Palmer Rapids, Ontario, for Katahdin, with Frank Rick, Trout Creek, Ontario, won reserve.

The Championship award for Ontario based on yield, marketable potatoes per acre, exhibit and cooking test was won this year by Frank Rick, Trout Creek, Ontario, in Parry Sound District with a yield of 836 bushels per acre. The prize is a Handsome Trophy, plus $250.00 in cash, and a trip to Toronto.

Prize winners from the U. S. A. were W. F. Haenke, Gilbert Minn., W. J. Mason, and August Newhaven, Virginia, Minn.; Elis Raati,, Gilbert, Minn.; and Thos. and Arvo Saari, Embarrass, Minn.

The judges were Prof. E. V. Hardenburg, Cornell University Ithaca, N. Y.; B. Baribeau, Ste. Anne de la Pocatiere, Que.; J. E. Birdsall, Edmonton, Alberta; and R. E. Goodin, Toronto, Ontario. — R. E. GOODIN

ERRATA

Fungicide-Insecticide Combinations in Michigan for 1948," by J. H.

In the August 1949 issue, in the article entitled "Field Tests of Muncie and W. F. Morofsky, Table 2 should be labelled Table 2. Table 1 of this article was omitted entirely and is inserted in this issue.

In the August issue in the first article, the names of the authors should be reversed, since L. L. Dean is the major author.

Page 283 — Last line should read "applied in dust gave control."

Page 285 — Third line from bottom "aphthalene acetic acid" should read "Alphanaphthalene acetic acid."

Page 286 — The fourth paragraph, line four should read "whether applied in talc" instead of "where applied in talc."

Page 286 — In the fifth paragraph the first sentence should read, "Drying dipped tubers at 135°F. significantly reduced the effect of napthalene acetic acid and its sodium salt at the three and nine-gram per bushel rates at application as compared with, etc."
